

# THE OHIO JOURNAL OF SCIENCE

VOL. XLIX

JANUARY, 1949

No. 1

## AN ADDITIONAL FOSSILIFEROUS MEMBER IN THE ALLEGHENY FORMATION (PENNSYLVANIAN) OF OHIO<sup>1</sup>

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### INTRODUCTION

In eastern Ohio stratigraphic members of marine and brackish water origin are present in the Pottsville, Allegheny, and Conemaugh formations or series of the Pennsylvanian system. None is known in the overlying Monongahela formation, and only one brackish member occurs in the still higher Dunkard series of Permian age. In our Pennsylvanian, the marine and brackish members characteristically overlie a coal in the normal stratigraphic succession although many coals lack such overlying members. Coal and a marine and/or brackish water unit, together with other lithologic types, occur in a definite stratigraphic succession called a cyclothem by Weller (1932, footnote, p. 1003, *Correlation and Extent of Pennsylvanian Cyclothem*s by H. R. Wanless and J. M. Weller. See also Weller, 1930, 1931, for further descriptive details). Many cyclothem occur above one another in the Pennsylvanian system of eastern and central North America, and a complete cyclothem has the following sequence of beds (See also Wanless, 1939, p. 8):

#### MARINE:

9. Shale containing clay ironstone bands and thin limestones
8. Limestone
7. Calcareous shale
6. Black shale

#### CONTINENTAL:

5. Coal
  4. Underclay
  3. Limestone
  2. Sandy and micaceous shale
  1. Sandstone
- Disconformity

<sup>1</sup>Published by permission of the State Geologist of Ohio, Columbus, Ohio.

<sup>2</sup>We are indebted to a number of persons for aid and encouragement during the preparation of this paper. Mr. John H. Melvin, State Geologist of Ohio, has been especially helpful to us during the study of the Dorr Run shale. Messrs. Merrill F. Aukland, Gerald L. Bell, and William H. Smith have rendered services in the field that facilitated our studies. Dr. Norman D. Newell, Department of Geology, Columbia University, New York City, and Dr. Walter Youngquist, Department of Geology, University of Idaho, Moscow, Idaho, have given special aid in the identification of fossil pelecypods and conodonts, respectively. The Geological Survey of Ohio has provided the services of Miss L. Beatrice Pugsley for drawing the stratigraphic sections and index map. Mr. W. C. Heilman took the pictures shown in Figs. 1-3. Carolyn Sturgeon, wife of the senior author, has assisted in the typing of the manuscript. A grant from The Ohio University Fund, Inc., has defrayed the photographic expenses and costs of printing the illustrations. We are indeed happy to acknowledge and to express our appreciation for all assistance and services given by the above persons and organizations.

In Ohio only two cyclothems, one associated with the Middle Kittanning coal in the Allegheny formation and another associated with the Anderson coal in the Conemaugh formation (Stout, 1939, 1947), are recognized as more or less complete. Inspection of Stout's stratigraphic charts shows that all other Ohio cyclothems are incomplete and that several may consist of as few as two members, although Stout and Lamborn (1924, pp. 238, 258, and 262) cite the occurrence of fossils in shale above the Upper Freeport coal in Center and Madison townships, Columbiana County, Ohio.

In the Allegheny formation five marine members are known to be present, and in ascending order these are the Putnam Hill limestone, Zaleski flint, Vanport limestone and flint, Hamden limestone and shale, and Washingtonville shale. The stratigraphic position of these members and their relationship to the other members of the cyclothem especially the underlying coals are shown in the following chart of the Allegheny formation which is modified from Stout (1947):<sup>3</sup>

| MEMBER                        | LITHOLOGY                        | THICKNESS |     |
|-------------------------------|----------------------------------|-----------|-----|
|                               |                                  | Ft.       | In. |
| Upper Freeport, No. 7.....    | Coal, patchy.....                | 3         | 0   |
|                               | Clay and shale.....              | 7         | 0   |
| Upper Freeport.....           | Limestone and marly shale.....   | 2         | 0   |
| Bolivar.....                  | Coal, local, thin.....           | 0         | 3   |
| Bolivar.....                  | Clay, flint and plastic.....     | 5         | 0   |
| Upper Freeport.....           | Shale or sandstone.....          | 33        | 0   |
| Lower Freeport or Rogers..... | Coal, patchy.....                | 1         | 0   |
|                               | Clay, impure.....                | 2         | 6   |
| Lower Freeport.....           | Limestone, local.....            | 1         | 0   |
| Lower Freeport.....           | Shale or sandstone.....          | 25        | 0   |
| Upper Kittanning.....         | Coal, local.....                 | 1         | 0   |
|                               | Shale and sandstone.....         | 10        | 0   |
| <i>Washingtonville</i> .....  | Shale, marine.....               | 4         | 0   |
| Middle Kittanning, No. 6..... | Coal, persistent.....            | 4         | 0   |
|                               | Clay, siliceous.....             | 3         | 6   |
| Salem.....                    | Limestone, impure, local.....    | 0         | 6   |
|                               | Shale with red kidney ore.....   | 10        | 0   |
| Strasburg.....                | Coal, local.....                 | 0         | 6   |
| Oak Hill.....                 | Clay, flint and plastic.....     | 4         | 0   |
|                               | Shale, siliceous.....            | 3         | 0   |
| <i>Hamden</i> .....           | Limestone, unsteady, marine..... | 4         | 0   |
| Lower Kittanning, No. 5.....  | Coal.....                        | 2         | 4   |
|                               | Clay, plastic.....               | 5         | 0   |
| Lawrence.....                 | Coal, shaly, local.....          | 0         | 4   |
|                               | Clay, flint and plastic.....     | 6         | 0   |
| Kittanning.....               | Shale and sandstone.....         | 8         | 2   |
| Ferriferous.....              | Ore, irregular.....              | 0         | 8   |
| <i>Vanport</i> .....          | Limestone, marine.....           | 6         | 0   |
| Scrubgrass.....               | Coal, local.....                 | 0         | 6   |
|                               | Shale, carbonaceous.....         | 5         | 0   |
| Clarion, No. 4A.....          | Coal, patchy.....                | 4         | 0   |
|                               | Clay, flint and plastic.....     | 5         | 0   |
| Canary.....                   | Ore, local.....                  | 0         | 6   |
| Clarion.....                  | Sandstone, irregular.....        | 10        | 6   |
| Winters.....                  | Coal, local.....                 | 1         | 0   |
| <i>Zaleski</i> .....          | Flint, impure, marine.....       | 1         | 0   |

<sup>3</sup>Marine members are italicized.

|                              |                          |      |   |
|------------------------------|--------------------------|------|---|
| Ogan.....                    | Coal, local.....         | 1    | 0 |
|                              | Shale and sandstone..... | 25   | 0 |
| Putnam Hill.....             | Limestone, marine.....   | 4    | 0 |
| Brookville, No. 4.....       | Coal, steady.....        | 2    | 0 |
| Total average thickness..... |                          | 212± | 0 |

This is the accepted number of marine members in the Allegheny formation of Ohio at present, and Wanless (1939, p. 47) has stated that the Washingtonville shale "is the highest marine horizon in the Allegheny of the Appalachian field."

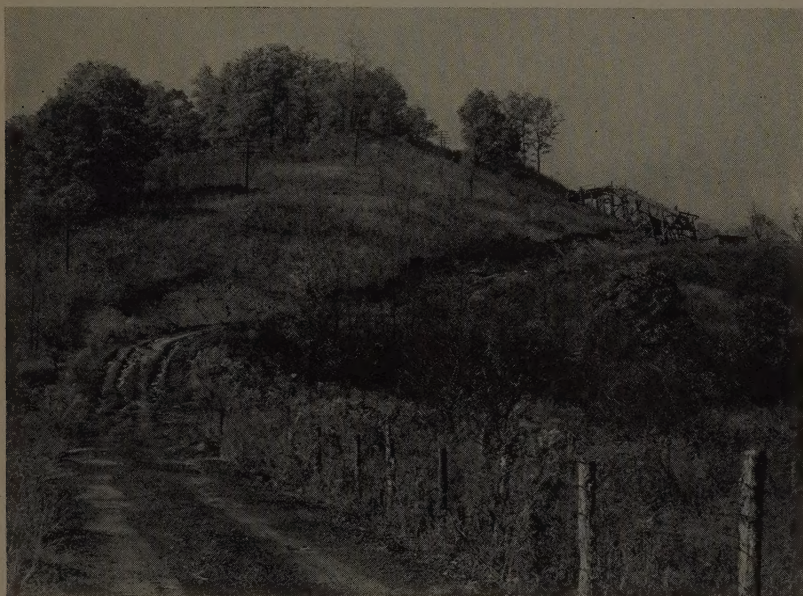


FIG. 1. East approach to the L. and M. Coal Co.'s strip mine on the southwest side of the Dorr Run valley, section 31, Ward Tp., Hocking Co., Ohio. The strip mine lies behind the tipple.

#### DESCRIPTION OF DORR RUN SHALE

At present the Geological Survey of Ohio has in progress a stratigraphic and economic survey of the Hocking Valley area in which we are participating. During this work we have found a marine or brackish water shale member overlying the Lower Freeport coal in Athens (Sturgeon) and Hocking (Merrill) counties. We are not the first to find or recognize this fossiliferous member; for E. B. Andrews as early as 1870 (1871, p. 87) found and recorded fossil *Lingula* above the Lower Freeport coal in the vicinity of Kimberly which is located on Minkers Run (also called Meekers Run) near Nelsonville in Athens County. Sturgeon rediscovered *Lingula* specimens at Kimberly in 1945 and learned of Andrews' original discovery in a search through the literature. He called the junior author's attention to them during the field work of the present (1948) season. The shales in which these fossils occur are similar to other shales in the section and hence do not stand out lithologically, and the inconspicuous fossils are relatively few in number and kind.



FIG. 2. Strip mine of the L. and M. Coal Co., section 31, Ward Tp., Hocking Co., Ohio. Arrow points to Lower Freeport coal and Dorr Run shale.



FIG. 3. Close view of Lower Freeport coal and Dorr Run shale shown in Fig. 2. White lines indicate top and bottom of the Dorr Run shale. Figs. 2 and 3 show the type exposure of the Dorr Run shale.

The more abundant fossils are *Lingula* and pectinoid clams, but other brachiopods and clams as well as gastropods, cephalopods, scaphopods, conodonts, and fish remains do occur. In view of the facts we believe it desirable to describe and name this member so that fellow workers in the Pennsylvanian of eastern Ohio will be on the alert for its occurrence elsewhere in the State.

We propose the name Dorr Run shale for this fossiliferous member overlying the Lower Freeport coal from an exposure on the southwest side of Dorr Run valley 1.6 miles northwest of the junction of the road along Dorr Run with the Logan-Nelsonville road (Route 33, mileage is from the junction of old Route 33 as shown on the topographic map and not from the present newer location of Route 33). The type section, located in the SW $\frac{1}{4}$ , NW $\frac{1}{4}$ , section 31, Ward Township, Hocking County, Ohio, is in an abandoned strip mine, but the entire section includes strata exposed along the side road from the vicinity of the 741 (elevation on topographic map) road intersection in the SE $\frac{1}{4}$ , NW $\frac{1}{4}$ , section 31. The strip mine was formerly operated by the L. and M. Coal Co. (now Liden Coal Co.) on the property of William Bowers and was first studied by Merrill. We have selected this exposure as the type not only because of its accessibility and probability of remaining exposed but also because it comes about as near as any exposure known to us of fulfilling the marine part of a typical cyclothem, although even here it is far from complete and typical (Figs. 1-3). The following section gives the succession of strata exposed both in the strip mine and along the secondary road extending from the Dorr Run road:

|                                                                                                                                                                         |                   | Ft. | In. |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-----|-----|
| 32. Sandstone, brown to gray with limonite stained surfaces, fine grained, micaceous, laminated, thin bedded or cross bedded, with few, greenish, shaly layers near top | Upper             | 5   | 4   |
| 31. Clay-shale, gray, very sandy, micaceous                                                                                                                             |                   | 0   | 8   |
| 30. Clay-shale, dark gray to black, some limonite stain on surfaces, silty                                                                                              | Freeport          | 3   | 8   |
| 29. Clay-shale, brown, ferruginous, silty                                                                                                                               |                   | 0   | 4   |
| 28. Shale, gray to olive drab, clayey to sandy, micaceous                                                                                                               |                   | 2   | 11  |
| 27. Shale, gray to dark gray, argillaceous, fossiliferous clams, with scattered, small, limonite nodules in upper part                                                  | Dorr              | 1   | 10  |
| 26. Shale, dark gray to black, fossiliferous                                                                                                                            |                   | 1   | 7   |
| 25. Coal, bony, shaly, fossiliferous                                                                                                                                    | Run               | 0   | 4   |
| 24. Shale, black, carbonaceous, argillaceous, fossiliferous                                                                                                             |                   | 0   | 6   |
| 23. Coal, shaly to bony, some bright streaks                                                                                                                            | Lower<br>Freeport | 1   | 1   |
| 22. Clay-shale, dark gray, carbonaceous                                                                                                                                 |                   | 0   | 6   |
| 21. Coal, bright, somewhat blocky, in thin layers                                                                                                                       |                   | 1   | 2   |
| 20. Clay, greenish gray, sandy, micaceous, slightly plastic, darker gray and more clayey with coaly streaks near top                                                    |                   | 4   | 6   |
| 19. Sandstone, gray to greenish gray, fine grained, micaceous, thin bedded                                                                                              |                   | 6   | 4   |
| 18. Sandstone, brown to buff, medium to coarse grained, micaceous, massive                                                                                              |                   | 23  | 10  |

|                                                                                                                                                                                                    |                              | Ft. | In. |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----|-----|
| 17. Shale, gray, silty, with coaly layers near base                                                                                                                                                | <i>Middle<br/>Kittanning</i> | 3   | 0   |
| 16. Coal, bright to bony, thickness variable                                                                                                                                                       |                              | 1   | 6   |
| 15. Clay, dark gray, plastic                                                                                                                                                                       |                              | 0   | 3   |
| 14. Coal, bright, blocky                                                                                                                                                                           |                              | 2   | 5   |
| 13. Clay-shale, dark gray                                                                                                                                                                          |                              | 0   | 2   |
| 12. Coal, bright, blocky                                                                                                                                                                           |                              | 0   | 10  |
| 11. Clay, gray, sandy, plastic                                                                                                                                                                     |                              | 1   | 0   |
| 10. Covered interval                                                                                                                                                                               |                              | 15  | 0   |
| 9. Shale, greenish gray, silty                                                                                                                                                                     | <i>Lower<br/>Kittanning</i>  | 15  | 3   |
| 8. Coal, weathered                                                                                                                                                                                 |                              | 0   | 3   |
| 7. Clay, poorly exposed                                                                                                                                                                            |                              | 2   | 9   |
| 6. Sandstone, buff to brown, medium grained, medium bedded near base, micaceous, ferruginous, grades upward into light gray to white, fine grained, thin bedded, argillaceous, micaceous sandstone |                              | 49  | 11  |
| 5. Covered interval                                                                                                                                                                                |                              | 9   | 9   |
| 4. Shale, gray, argillaceous, containing layers and small nodules of limonite                                                                                                                      |                              | 8   | 0   |
| 3. Shale, gray, argillaceous, fossiliferous                                                                                                                                                        | <i>Putnam Hill</i>           | 0   | 6   |
| 2. Coal, shaly to bright                                                                                                                                                                           | <i>Brookville</i>            | 0   | 1   |
| 1. Clay, light gray with dark gray top, very plastic                                                                                                                                               |                              | 5   | 4   |

A comparison of the strata associated with the Lower Freeport coal in the above section with a theoretical complete cyclothem shows that the freshwater limestone (3), calcareous shale (7), marine limestone (8), and shale containing clay ironstone bands and thin limestones (9) are absent in the type section of the Dorr Run shale. Possibly the shale bearing the fossil clams (27) is a feeble representation of the calcareous shale (7) of a complete cyclothem.

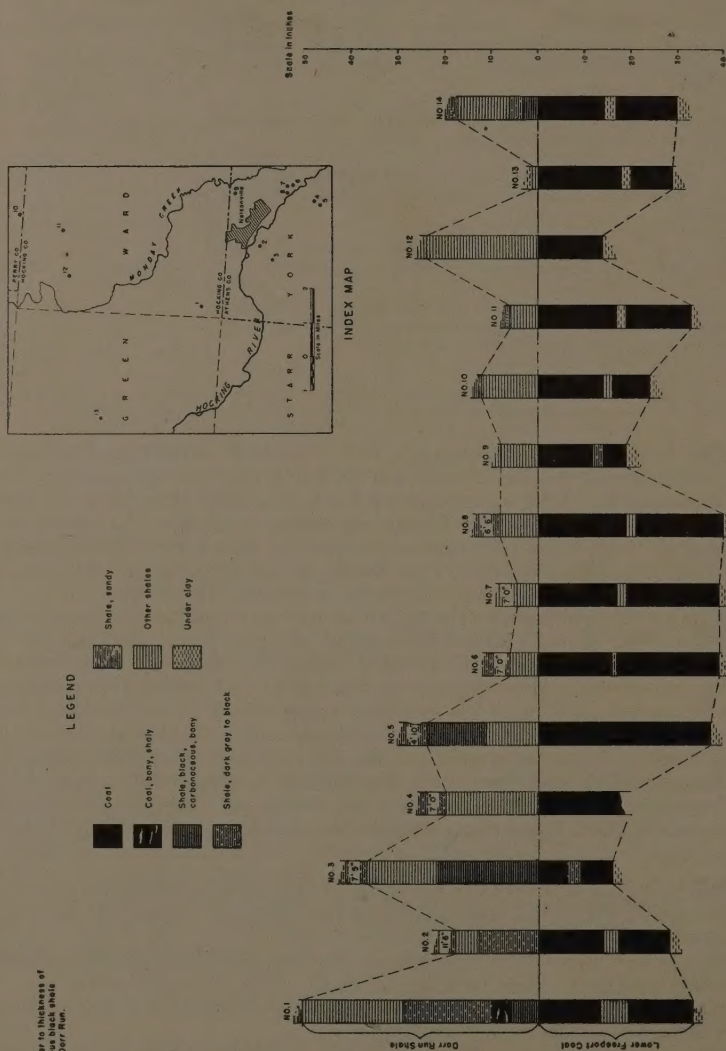
A freshwater limestone in or below the Lower Freeport underclay is present at many places in Ohio as is shown in the following section measured along a secondary road at the ridge crest south of Snake Hollow in NW $\frac{1}{4}$ , NE $\frac{1}{4}$ , section 18, York Township, Athens County:

|                                                                                                                                                               |                 | Ft. | In. |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----|-----|
| 8. Shale, gray to olive drab                                                                                                                                  |                 |     |     |
| 7. Shale, gray, argillaceous, sparingly fossiliferous in basal 2 inches                                                                                       | <i>Dorr Run</i> | 0   | 8   |
| 6. Coal, bright, blocky, with numerous, thin, dull, irregular partings including much fusain, free sulphur on weathered surfaces                              | <i>Lower</i>    | 1   | 0   |
| 5. Shale, dark gray to black, carbonaceous, with numerous fossil megaspores and thin coaly partings                                                           |                 | 0   | 2   |
| 4. Coal, bright, blocky, with numerous dull partings of fusain and some pyrite, melanterite and free sulphur on weathered surfaces                            |                 | 0   | 5   |
| 3. Clay, gray, ferruginous, silty, sandy, micaceous, with scattered, small, limonite and pyrite concretions                                                   | <i>Freeport</i> | 5   | 10  |
| 2. Limestone, greenish gray, nodular, ferruginous, with network of thin, irregular, limonite partings and with some pyrite, embedded in light gray clay-shale |                 | 2   | 0   |
| 1. Shale, gray to olive drab                                                                                                                                  |                 |     |     |

Here the Lower Freeport limestone is well developed, nodular, and ferruginous. A casual inspection at this locality did not show any fossils in the limestone, but a freshwater fauna of at least clams, ostracodes, and annelid worm tubes is present in the Lower Freeport limestone locally elsewhere in Ohio. The fossils in the *Dorr Run* shale seem to be restricted to the several inches immediately overlying the coal. It is possible, however, that fossils are present higher above the coal but unrecognizable because of the weathered condition of the shale.

Plate I is a chart which shows the thickness and character of the Lower Freeport coal and *Dorr Run* shale at all localities where we have found fossils in the *Dorr Run* shale. We have failed to find fossils above the same coal at other places within the area shown in the index map of Plate I, but we believe that fossils must certainly be present at some of the localities inspected and found wanting because of the weathered and slumped condition of the outcrop. It should be mentioned that weathered and slumped conditions do not prevail at all locations where no fossils were found. The following are descriptions of the locations at which the Lower Freeport and *Dorr Run* members are shown on Plate I. The elevation given for each location below is approximate for the Lower Freeport coal and the *Dorr Run* shale:

1. Exposure in L. and M. Coal Co.'s abandoned strip mine on the southwest side of *Dorr Run* valley, SW $\frac{1}{4}$ , NW $\frac{1}{4}$ , section 31, Ward Tp., Hocking Co., Ohio. This is the type exposure of the *Dorr Run* shale. Elevation: 910±.
2. Exposure on west side of Nelsonville-Minkers Run road, SW $\frac{1}{4}$ , SW $\frac{1}{4}$ , section 24 (unnumbered on topographic map), York Tp., Athens Co., Ohio. Elevation: 800±.
3. Exposure on west side of Nelsonville-Minkers Run road, SE $\frac{1}{4}$ , NE $\frac{1}{4}$ , section 29, York Tp., Athens Co., Ohio. Elevation: 830±.
4. Exposure in abandoned strip mine on north side of Minkers Run valley and northwest of Kimberly, NW $\frac{1}{4}$ , SE $\frac{1}{4}$ , section 16, York Tp., Athens Co., Ohio. Elevation: 730±.
5. Exposure in abandoned strip mine on south side of Minkers Run valley and west of Kimberly, south-center, section 16, York Tp., Athens Co., Ohio. Elevation: 735±.
6. Exposure in abandoned strip mine north of Route 33 and east of Happy Hollow road, SW $\frac{1}{4}$ , SW $\frac{1}{4}$ , section 11, York Tp., Athens Co., Ohio. Elevation: 735±.



Note--  
Figures refer to thickness of  
non-fossiliferous black shale  
overlying the Dorr Run.

Chart showing thickness and character of the Lower Freeport coal and Dorr Run shale at all known exposures of the Dorr Run shale.

7. Exposure on west side of Happy Hollow road and short distance north of Route 33, NW $\frac{1}{4}$ , SW $\frac{1}{4}$ , section 11, York Tp., Athens Co., Ohio. Elevation: 735±.
8. Exposure at abandoned mine entrance on north side of Route 33, NE $\frac{1}{4}$ , SE $\frac{1}{4}$ , section 17 (unnumbered on topographic map), York Tp., Athens Co., Ohio. Elevation: 733±.
9. Exposure along both sides of secondary road at ridge crest south of Snake Hollow, NW $\frac{1}{4}$ , NE $\frac{1}{4}$ , section 18, York Tp., Athens Co., Ohio. Elevation: 790±.
10. Exposures in ravine on northeast side of Route 216, SW $\frac{1}{4}$ , SW $\frac{1}{4}$ , section 33, Coal Tp., Perry Co., Ohio. Elevation: 890±.
11. Exposure on west side of road, SE $\frac{1}{4}$ , NW $\frac{1}{4}$ , section 23, Ward Tp., Hocking Co., Ohio. Elevation: 890±.
12. Exposure on north side of road just south of Downhour School, NW $\frac{1}{4}$ , SW $\frac{1}{4}$ , section 29, Ward Tp., Hocking Co., Ohio. Elevation: 920±.
13. Exposure on north side of road at crest of hill between 992 and 828 road intersections, NE $\frac{1}{4}$ , SE $\frac{1}{4}$ , section 22, Green Tp., Hocking Co., Ohio. Elevation: 1045±.

The 14th stratigraphic section on Plate I is an average composite one of the Lower Freeport coal and Dorr Run shale for the localities at which we have found the Dorr Run shale. In the area studied by us the Lower Freeport coal has an average thickness of 30 inches and characteristically has a single parting of shale or clay with an average thickness of 2.5 inches. The average thickness of the lower bench of coal is 13 inches and of the upper bench 14.5 inches. The Lower Freeport where associated with the Dorr Run shale is not a coal of the highest quality, and while much of it is bright and blocky it tends to have considerable fusain and pyrite and locally to become shaly and bony.

The Dorr Run shale has a known average thickness of 17 inches. It is very probable that the average thickness is too small; for a more thorough search would likely reveal fossils scattered through part of the considerable thickness of dark shale that overlies the Lower Freeport coal in part of York Township of Athens County. The Dorr Run member is typically a gray to dark gray or even black, argillaceous, carbonaceous, fossiliferous, marine shale, but in the vicinity of Downhour School in Ward Township of Hocking County it is light gray and argillaceous. The typical Dorr Run shale is lithologically quite similar to the type Washingtonville shale, but except for the pectinoid clams the faunas of these two shales do not seem very much alike. Studies, when complete, may show more similarities than are now apparent between these two faunas.

On the basis of the stratigraphic evidence available we suggest the following addition and modification to the Lower Freeport cyclothem in Ohio:

|                                                                                                   |                 | Ft. | In. |
|---------------------------------------------------------------------------------------------------|-----------------|-----|-----|
| 6. Shale, gray to olive drab, silty to sandy                                                      |                 |     |     |
| 5. Shale, gray to black, argillaceous and/or carbonaceous, fossiliferous, marine, locally present | <i>Dorr Run</i> | 1   | 6   |
| 4. Coal, locally present                                                                          | <i>Lower</i>    | 1   | 0   |
| 3. Underclay, impure                                                                              |                 | 2   | 6   |
| 2. Limestone, freshwater, locally present                                                         |                 | 1   | 0   |
| 1. Sandstone and shale                                                                            | <i>Freeport</i> | 25  | 0   |
| Disconformity                                                                                     |                 |     |     |

The only change that we have made is the addition of the Dorr Run shale member, and for the remainder of the Lower Freeport cyclothem we have used Stout's descriptions and average thicknesses. This seems feasible, since his studies are based on many sections over the entire eastern part of Ohio and our studies are of local extent. In our sections, however, the Lower Freeport coal has an average thickness of about 30 inches and a 2.5-inch shale or clay parting near the middle (Plate I). The discovery of the Dorr Run shale member makes a total of three cyclothem in the Pennsylvanian of Ohio that are more or less complete. Additional studies in Ohio and elsewhere may add facts that will warrant further modifications in our understanding of the Lower Freeport coal and associated strata.

#### DORR RUN FAUNA

The better of the known collecting localities for Dorr Run shale fossils are at the type area and along the Nelsonville-Minkers Run road at localities 2 and 3 as shown on Plate I. The fauna is not large and has not been completely studied, but our present knowledge indicates that the assemblage of fossils is more extensive than we believed at the beginning of our joint study. There have been collected about 18 different kinds of Dorr Run fossils to date, but several of these because of poor preservation or of too few specimens are very inadequately represented. The tentative fossil list, including genera and species as far as possible, is as follows:

##### I. BRACHPODA:

1. *Lingula carbonaria* Shumard.
2. *Orbiculoidea missouriensis* (Shumard).

##### II. PELECYPODA:

1. *Aviculopecten* aff. *eaglenis* (Price).
2. *Cardiomorpha* sp.
3. *Dunbarella knighti* Newell?
4. *Naiadites* ? sp.
5. "Solenomya" sp.

##### III. GASTROPODA:

1. *Patellilabia* sp.
2. Unidentified pleurotomarid genus.
3. Unidentified high spired genus.

##### IV. SCAPHOPODA:

1. *Plagioglypta meekiana* (Geinitz)?

##### V. CEPHALOPODA:

1. *Pseudorthoceras knoxense* (McChesney)?
2. *Metacoceras* sp.

##### VI. CONODONTS:

1. *Hibbardella*? sp.
2. *Hindeodella* sp.
3. *Idiognathodus* sp.
4. *Ozarkodina* sp.
5. *Sireptognathodus* sp.

##### VII. VERTEBRATA:

1. Fish scales and spines.

The fossils and the lithology of the Dorr Run shale do not indicate a normal marine environment at the time of deposition but rather near shore and shallow water conditions. Dr. Youngquist, during his identification of the conodont genera, observed from their occurrence with fish remains and fragments of fossil

wood, that the environment was "perhaps a near shore, estuary or lagoon facies . . . ." He was particularly interested in the association of the conodonts with the remains of fish and plants, both associations of which, he points out, are known elsewhere. Dr. Newell after an inspection of the Dorr Run pelecypods believes "that the pelecypods are marine, although they may be representatives of a sub-normally saline marine environment."

The absence of brachiopods with calcareous shells and of other fossils commonly found in the Pennsylvanian marine members of Ohio may further substantiate a shallow water, near shore environment, although the dark muds were certainly in part responsible for the absence of some of them. The few cephalopod and gastropod shells may have floated in after the death of their owners, but such a means of transportation seems unlikely for the scaphopod shells which are open at both ends.

The dark gray to black color of most of the shale should be indicative of a considerable amount of contained carbonaceous matter. The fossil plants, while not abundant, include both woody material and a few leaves. These facts probably also indicate a near shore environment. A recent chemical analysis of the dark gray and black shale from locality 4 near Kimberly by the Geological Survey of Ohio showed, however, that the shale is more than 90% ash.

From the available evidence it seems probable that the Dorr Run shale represents the black shale which is the basal marine unit of a typical cyclothem. Marine conditions seem to have developed no further in Dorr Run time and instead were shortly replaced by the deposition of dark muds under a continental environment. The sea threatened an invasion but never firmly established itself in Ohio during the deposition of the Lower Freeport-Dorr Run cyclothem.

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# A STUDY OF THE ADULT MOSQUITO POPULATION OF A NORTHERN OHIO WOODS

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The data presented in this paper are based on collections made by the author at various times over a two-year period, 1946-1948. The work is being carried out much more intensively at the present time so a more detailed report should be forthcoming; however, the present paper, at least, lists the species so far collected.

The area studied is shown on the Cleveland Quadrangle, U. S. Geological Survey Map (Fig. 1), and covers an area of only four square miles mostly because

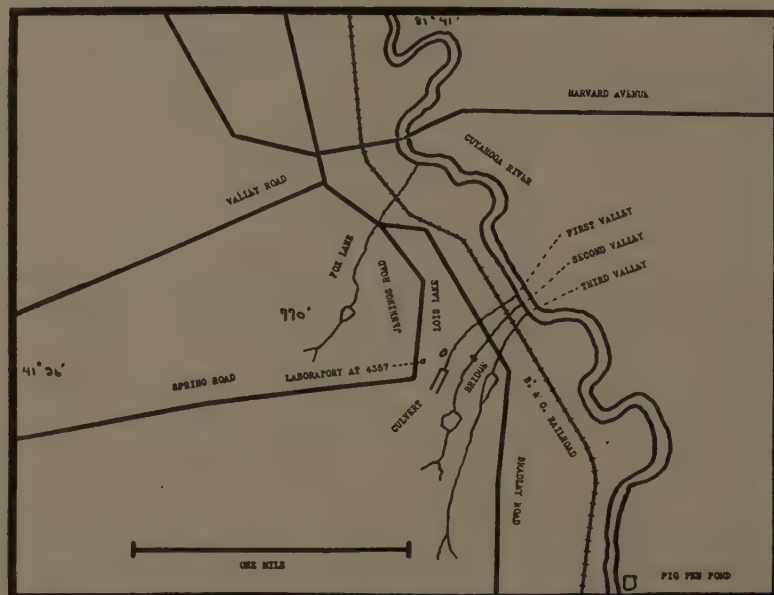


FIG. 1. Map of area (Cleveland, Ohio).

of the author's lack of sufficient transportation. Much of the region is approximately seven hundred seventy feet above mean sea level with three valleys having approximate depths of eighty feet cutting through close to the laboratory. The top land is mostly utilized by market gardeners, but open grassland is common. In the ravines, trees and shrubbery grow in abundance.

Dominating species of trees are the Tulip Tree, *Liriodendron tulipifera* L., and Beech, *Fagus americana* Sw., with Sycamores, *Platanus occidentalis* L., and Hop Hornbeams, *Ostrya virginiana* K., abundant. Other plants include most of those generally found in beech-maple climax forests. Because much of the land is water-logged, marsh-dwelling plants are common. The Jewel Weed, *Impatiens*

*biflora* Walt., immediately fills in any area left open by eroding of a bank or the death of a tree. Water-holes, almost completely filled-in with leaves, are common, and wherever these are exposed to sunlight, aquatic plants such as Cattails, *Typha latifolia* L., Arrowheads, *Sagittaria cuneata* S., and Hornwort, *Ceratophyllum demersum* L., grow profusely.

Mosquito collections and identifications were made according to methods generally used by workers in that particular field. The bibliography lists two references which describe the subjects fully.

#### ADULT COLLECTIONS

|                                        |             |
|----------------------------------------|-------------|
| Indoors (evening).....                 | (72 adults) |
| <i>Culex restuans</i> Theobald.....    | 45%         |
| <i>Culex pipiens</i> Linnaeus.....     | 30          |
| <i>Anopheles punctipennis</i> Say..... | 20          |
| <i>Aedes triseriatus</i> Say.....      | 5           |

Rain-water barrels situated close by served as the breeding place for *C. restuans*. *A. punctipennis* adults were found flying about indoors as late as November.

|                                         |             |
|-----------------------------------------|-------------|
| Outdoors (evening—not biting).....      | (23 adults) |
| <i>Aedes vexans</i> Meigen.....         | 92%         |
| <i>Culex salinarius</i> Coquillett..... | 8           |

|                                     |              |
|-------------------------------------|--------------|
| Winter Resting Places.....          | (346 adults) |
| <i>Culex restuans</i> Theobald..... | 98%          |
| <i>Culex pipiens</i> Linnaeus.....  | 2            |

|                                               |              |
|-----------------------------------------------|--------------|
| Summer Resting Places.....                    | (184 adults) |
| <i>Culex salinarius</i> Coquillett.....       | 40%          |
| <i>Culex restuans</i> Theobald.....           | 40           |
| <i>Anopheles punctipennis</i> Say.....        | 4            |
| <i>Culex apicalis</i> Adams.....              | 4            |
| <i>Uranotaenia sapphirina</i> Osten Sac.....  | 4            |
| <i>Megarhinus septentrionalis</i> D. & K..... | 4            |
| Unknown.....                                  | 4            |

|                                              |              |
|----------------------------------------------|--------------|
| Light Trap Collections.....                  | (211 adults) |
| <i>Culex restuans</i> Theobald.....          | 43%          |
| <i>Aedes vexans</i> Meigen.....              | 34           |
| <i>Anopheles punctipennis</i> Say.....       | 5            |
| <i>Mansonia perturbans</i> Walker.....       | 5            |
| <i>Culex pipiens</i> Linnaeus.....           | 3            |
| <i>Culex salinarius</i> Coquillett.....      | 2            |
| <i>Aedes triseriatus</i> Say.....            | 2            |
| <i>Culiseta morsitans</i> Theobald.....      | 1.5          |
| <i>Culex apicalis</i> Adams.....             | 1.5          |
| <i>Uranotaenia sapphirina</i> Osten Sac..... | 1.5          |
| <i>Culex erraticus</i> Dyar & Knab.....      | 1.5          |

|                                          |              |
|------------------------------------------|--------------|
| Biting Stations.....                     | (586 adults) |
| <i>Aedes vexans</i> Meigen.....          | 51%          |
| <i>Aedes canadensis</i> Theobald.....    | 14           |
| <i>Mansonia perturbans</i> Walker.....   | 13           |
| <i>Aedes triseriatus</i> Say.....        | 6            |
| <i>Anopheles punctipennis</i> Say.....   | 4            |
| <i>Culex salinarius</i> Coquillett.....  | 3            |
| <i>Aedes trivittatus</i> Coquillett..... | 2            |
| <i>Culex restuans</i> Theobald.....      | 1            |
| <i>Aedes excrucians</i> Walker.....      | .9           |

|                                           |   |
|-------------------------------------------|---|
| <i>Culex erraticus</i> Dyar & Knab.....   | 7 |
| <i>Anopheles quadrimaculatus</i> Say..... | 7 |
| <i>Aedes fitchii</i> Felt & Young.....    | 7 |
| <i>Aedes stimulans</i> Walker.....        | 6 |
| <i>Aedes sticticus</i> Meigen.....        | 6 |
| Unknown.....                              | 6 |
| <i>Aedes cinereus</i> Meigen.....         | 4 |
| <i>Aedes thibaulti</i> Dyar & Knab.....   | 4 |
| <i>Culex apicalis</i> Adams.....          | 4 |

The last species on the list above was represented by a single specimen, gorged with blood, which did not attempt to bite but insisted upon resting on the arm of the author along with others which were feeding.

The "Unknowns" were specimens which were damaged so badly that they could not be identified. *A. quadrimaculatus* was a fierce daytime biter when its resting place was invaded. Up to the present time, no distribution pattern could be determined for the various larvae found.

A biting station was set up adjacent to a temporary pool, labeled "Pig Pen Pond" on the map, during the last week of May, 1948. Ninety-seven adults were collected within twenty minutes, as listed below, but since the station was somewhat away from the points where most of the other collections were made, the results were not included in with the others. Large numbers of *Culex apicalis* larvae were collected in the water.

|                                          |        |
|------------------------------------------|--------|
|                                          | Adults |
| <i>Aedes stimulans</i> Walker.....       | 61     |
| <i>Aedes fitchii</i> Felt and Young..... | 18     |
| <i>Aedes excrucians</i> Walker.....      | 11     |
| <i>Aedes vexans</i> Meigen.....          | 7      |

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# AN ECOLOGICAL COMPARISON BETWEEN THE AVIFAUNAS OF OHIO AND DENMARK

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## INTRODUCTION

It is always of great interest for the ornithologist to visit new areas and see new birds. When in a new region the ornithologist invariably compares the new area with his home region, looks for birds he knows and birds he does not know; and all of what he sees is grouped and arranged according to how the bird life is back home.

When the ornithologist finds himself in quite another part of the world he first really starts in to wonder and compare. Familiar species are greeted as old friends; species closely related to familiar ones enter as components of the avifaunistic picture, substituting well-known ones. New and unknown species are studied with the eagerness of a curious boy in the woods.

Gradually the bird communities of the new area are dissolved in their components; species, that at the beginning seemed so unfamiliar, are now found to occupy the same ecological niches as some known species back home.

Finally, after having been in the new area a sufficient length of time, the ornithologist feels more or less "at home," because the composition of various bird communities now seems familiar.

I have had the opportunity now for two years to study at the Ohio State University, Columbus, Ohio, as a Research Fellow of the Ohio Wildlife Research Unit. Coming from my cooler northern homeland, Denmark, the stay in this much more southern area has been of utmost interest and fascination to me. My first meetings with hummingbirds and vultures will always be red letter days for me.

The objective of this study is to show similarities and differences in the avifaunas of these two widely separated regions and attempts to explain some of the reasons underlying those conditions.

The justification for presenting this paper is the fact that Ohio and Denmark, in spite of their belonging to two different continents and placed at quite different latitudes, yet show a degree of similarity in avifaunistic composition. This is most pronounced with the shoreline community, of which Denmark can show a high diversity and richness, whereas the Lake Erie shoreline of Ohio is but a small part and in many places little or not at all suitable for shorebirds and waterfowl.

## CHARACTERISTIC FEATURES OF OHIO AND DENMARK

The location of Ohio and Denmark on two different continents and at quite different latitudes does not suggest many possibilities of similarity in general features. Yet, several conditions are more or less alike, e.g., the land-use patterns. On the other hand, many differences occur, as the very hot Ohio summers, the

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The author wishes to express appreciation and thanks to Dr. Daniel L. Leedy, Leader, the Ohio Wildlife Research Unit; Dr. John N. Wolfe, the Ohio State University; Dr. S. Charles Kendeigh, the University of Illinois; Dr. Edward S. Thomas, the Ohio State Museum, and Dr. Finn Salomonsen, Universitetets Zoologiske Museum, Copenhagen, for their helpful suggestions in the preparation of the manuscript.

intensive and violent rains of Ohio, the light summer nights of Denmark, and many other characteristic features of the two countries.

It has therefore seemed advisable, before making an avifaunistic comparison, to discuss briefly the most conspicuous similarities and differences in the general features of the two areas.

### (a) Climate

The rather great differences in the climates of Ohio and Denmark are due not only to the different geographical positions, Ohio being situated at around 40° n. lat., Denmark at 56° n. lat., but also by the fact that Ohio has a continental climate as part of a vast continent, whereas Denmark has an insular or maritime climate, tempered by the surrounding sea.

The greatest differences, which also will appear from the graph, Fig. 1, may be summarized as follows (data from Alexander and Patton, 1929, and H. Larser. & Bo Bramsen, 1943):

Ohio has rather cold winters with unsteady cold weather; the winter is characterized by relatively little snow, occasional extremely low temperatures occurring during cold spells and many thaws and fairly mild weather between the cold spells.

Denmark has fairly mild winters considering its northern location, with prolonged cold periods when winter really starts in, which does not happen every year; however, the winters of 1940-42, and 1947 were extremely long and cold. The cold is more steady, with periods of continuous frost lasting as long as 40 days.

Ohio has very hot, sunny and long summers, whereas the summers of Denmark are short and cool with much less sunshine. Some summers only a week or a few weeks are vacation weather with sunshine and warmth in Denmark. Denmark has an esthetic and practical advantage over Ohio in its light summer nights, characteristic of the northern latitudes, namely, in the months of May, June and July.

The annual mean temperature for Ohio is 10.5° C., in Denmark 7.4° C. The highest temperature measured in Ohio is 45° C., in Denmark 35.8° C. The lowest temperature measured in Ohio is -39° C., in Denmark -31° C.

The rainfall in Ohio is great, averaging 988 mm. a year; maximum precipitation a year, 1,278 mm.; the driest year had 711 mm. rainfall. The rainfall in Denmark is relatively slight, averaging 612 mm. a year; maximum precipitation a year, 805 mm.; driest year, 491 mm.

The relative humidity is less in Ohio than in Denmark, averaging 71 and 83 per cent respectively.

Ohio averages many more hours of sunshine than Denmark and as examples the figures for the summer months may be given. In June Ohio has 306, Denmark 261 hours of sunshine; in July Ohio has 327, Denmark 250 hours of sunshine, and in August Ohio has 286, Denmark 227 hours of sunshine.

Finally, it may be mentioned that it is very windy in Denmark. Annually only 4% of the days are calm; the force of the wind averages 6-8 m. per second (in winter 7.5, in summer 6.1). Highest wind velocity measured in Denmark was 35 m. per second.

### (b) Topography and land-forms

Parts of Ohio and Denmark are similar in topography, namely, the flat regions of unglaciated Ohio and the flat,undra-like heath of unglaciated western Denmark and to some extent also rather flat areas on some of the islands. Eastern Ohio is hilly and undulating and is similar to parts of eastern Jutland.

The characteristic features of Denmark are its long shoreline, the long fjords cutting into the country, the many islands scattered around in the sea, the bays and marshes, the heath, and the sand-dunes along the sea-shore. Ohio has nothing comparable to these features, except for the Lake Erie shoreline and

the Bass Island group in the lake. Rocky islands, belonging to Denmark, are found in the Baltic Sea.

Taken as a whole, however, the two areas are dissimilar. Greatest similarity is found between the Lake Erie shoreline of Ohio and the Danish sea-shoreline; and as it will be shown later on, it is in these areas that the greatest similarities are to be found in the avifauna of the two countries.

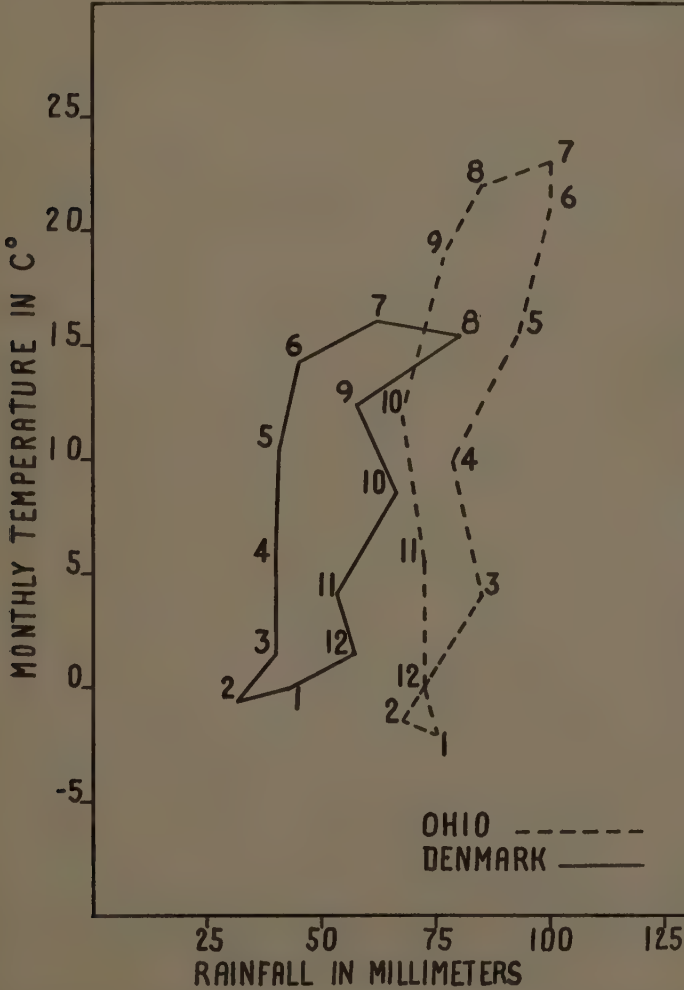


FIG. 1. Climograph of Ohio and Denmark. Months are indicated by the numbers 1-12.

### (c) Vegetation

Ohio has a rich and varied flora composed of approximately 2200 flowering plants (including 500 introduced species), 69 ferns, and 700 mosses and lichens. Several forest climaxes are found, as Mixed-mesophytic and Hemlock-Beech; the most common trees are the oaks, comprising 39.3% of the total forest area, followed closely by beech, maples, elm, ashes, hickories, etc. In all 120 varieties of native trees are found in Ohio. In the southeastern and eastern parts of the state conifers occur on drier sites; most common are Virginia pine, *Pinus virginiana*, and Pitch pine, *Pinus rigida*. Fourteen per cent of the total area is forested, and of this area 99% is deciduous forest, and 1% conifers.

Except for the forest land the main part of Ohio is farmland without characteristic or outstanding plant communities.

The vegetation of Denmark is central European with northern and boreal characteristics in certain areas, e.g., the heath. The flora is composed of about 1400 species of flowering plants, 30 ferns and 450 species of mosses and lichens. The climax forest type is deciduous forest with beech, *Fagus silvatica*, as the main tree, but, in addition, oaks, ashes, linden, birch, elm, etc., are found. In Jutland the dominating forest type is conifers, mainly Norway spruce, *Picea abies*, pines and firs; 8.5% of the land area is forested, and of this area 43% is deciduous forest, and 57% conifers. Characteristic for the Danish forest is its few tree species, the 5 main species occupying as much as 84% of the total forest area.

Another characteristic of the Danish flora is the tundra-like heath in the former unglaciated part of western Jutland; the heath, bogs and sand-dunes occupy about 10% of the total land area. The characteristic plant of the heath is heather, *Calluna vulgaris*, and other common species are cranberry, *Vaccinium vitis-idaea*, black crow-berry, *Empetrum nigrum*, lichens and mosses.

Along the west coast of Jutland and also in other places several rows of sand-dunes are found, building a barrier against the violent storms from the sea. Characteristic plants of the sand-dunes are lyme-grass, *Elymus arenarius*, and sea sand-reed, *Ammophila arenaria*.

### (d) Land-use

The land-use in Ohio and Denmark is similar in that farm land occupies about three-fourths of the total area, and the rest is occupied by forests, towns, roads, etc. Denmark has a 10% area, namely heath, bogs and sand-dunes, of which no comparable unit is found in Ohio.

Both states are thus mainly agricultural, but differences in crops, farming methods and soil types result in a rather different general appearance of farm lands. Ohio farms are rather large, averaging 99 acres per farm, whereas the average Danish farm covers 42 acres. Several big estates, comprising many hundred and up to several thousand acres are found in Denmark. Most of the farm land in Denmark is more rolling than in Ohio. Ohio fields are much bigger than average Danish fields; Ohio fields are mostly rectangular and regular in shape, whereas most Danish fields (mainly because of age and the very early dividing up of land) are rather irregular in shape. Many fields in Denmark are divided by living fencerows, and, in Jutland, windbreaks are very common. As a matter of fact they are a necessity for man's existence in that region. In Ohio, corn, wheat, oats and soybeans are the main crops, whereas in Denmark, barley, oats, beets and rye are the main crops.

The population density is a little different in the two areas. In Ohio there are 168 inhabitants per square mile (1940), in Denmark there are 244 inhabitants per square mile (1945).

TABLE I  
LAND-USE PATTERNS IN OHIO AND DENMARK

|                          | Ohio (1930) | Denmark (1931) |
|--------------------------|-------------|----------------|
| Farm land.....           | 82.0%       | 75.0%          |
| Forests.....             | 14.0%       | 8.5%           |
| Heath, dunes.....        |             | 10.0%          |
| Towns, gardens, etc..... | 2.0%        | 2.5%           |
| Roads, hedges.....       | 2.0%        | 2.0%           |
| Lakes and streams.....   |             | 2.0%           |

#### A COMPARISON OF OHIO AND DENMARK AVIFAUNAS TO SPECIES

The results of a comparison between Ohio and Danish avifaunas depend entirely upon how such a comparison is made.

If the list of identical species, given in Table 2, is used as a basis, without further consideration, it will be seen that ca. 100 species are alike, and it might accordingly be concluded that the avifaunas are much alike, almost 30% of the species being identical.

If a visit were made to a Lake Erie marsh or another waterfowl area, the number of various ducks, terns, gulls, bitterns, gallinules, coots, etc., would make the Dane feel very much at home.

If on the other hand a visit were made to Neotoma Valley in Hocking county, the differences would be so striking, that the Dane could hardly find one familiar species.

Similarly an Ohioan would feel homesick and helpless if put out on the tundra-like heaths and moorlands of western Jutland in Denmark; even the bird life of the woods would be new and unknown to him.

A closer consideration of the whole matter would therefore seem desirable.

For this reason a list (Table 2) is first given to be used as a basis for a qualitative comparison.

As indicated in Table 2, a total of 99 species of birds have been recorded from both Ohio and Denmark. This means that 29% of the birds recorded in Ohio have been reported in Denmark, and that 30% of the birds recorded in Denmark have also been reported in Ohio.

The total number of species recorded in Ohio is 343 (Trautman, 1935: 331 species, plus 12 species by Borror, 1941) of which 152 or 44% of the total number are regular and fairly common to common breeding birds.

The total number of species recorded in Denmark is 334 (Löppenthin, 1946: 333 species plus pheasant, which species is included in the Ohio list, too), of which 159 or 48% of the total number are regular, and fairly common to common breeding birds.

Although one may get the impression that there is a fairly high similarity between the composition of the avifaunas of Ohio and Denmark, a close analysis will, however, show that this is not the case. A very high number of the species are casual, several with only one record, in either or both lands, and only a few are common transients or breeding birds in both areas.

Artificial introductions account for 6 species, namely, mute swan, European partridge, starling, and English sparrow, that have been introduced into the United States from Europe, and either released in, or spread from releases to, Ohio; Canada geese have been introduced to a bird park in Sweden from where they, during the winter, have migrated to Danish coasts; released Canada geese in Danish parks are now breeding in a few places. The pheasant was introduced in both Denmark and Ohio.

TABLE II  
LIST OF BIRD SPECIES RECORDED

List of bird species recorded from Ohio and Denmark, showing subspecific similarities and differences, and stating respective occurrence. System and nomenclature followed as by Löppenthin (1946); Ohio records after Trautman (1935) and Borror (1941). Key to symbols used: C = Common; Ca. = Casual (accidental or far from its usual range); E = Extirminated in Ohio; L = Local; M = Migrant; N = Nests; R = Rare, but few recorded yearly; Res. = Resident, found at all seasons; Rec. = Record; S = Summer; U = Uncommon, occurring but in small numbers; V = Very; W = Winter; ? = Old established record being questioned, due to lack of any proof. Combinations as e.g., VRM, mean accordingly: very rare migrant. A dash (—) under the subspecific heading means that no subspecies are found, and the species are thus identical.

| COMMON NAME                  | SCIENTIFIC NAME                  | SUBSPECIES IN            |                          | OCCURRENCE IN  |             |
|------------------------------|----------------------------------|--------------------------|--------------------------|----------------|-------------|
|                              |                                  | Ohio                     | Denmark                  | Ohio           | Denmark     |
| Red-throated loon...         | <i>Colymbus stellatus</i> ...    | —                        | —                        | VRM            | CW, US      |
| Black-throated loon...       | <i>Colymbus arcticus</i> ...     | —                        | —                        | ?              | CW, US      |
| Common loon...               | <i>Colymbus immer</i> ...        | —                        | —                        | UM             | UW, RS      |
| Horned grebe...              | <i>Podiceps auritus</i> ...      | —                        | —                        | CM             | UM, UW      |
| Eared grebe...               | <i>Podiceps nigricollis</i> ...  | <i>californicus</i> ...  | <i>nigricollis</i> ...   | Ca.            | NL, RM      |
| Leach's petrel...            | <i>Oceanodroma leucorhoa</i> ... | —                        | —                        | 1 Rec.         | Ca.         |
| Gannet...                    | <i>Morus bassanus</i> ...        | —                        | —                        | Ca.            | LSW         |
| Black-crowned night heron... | <i>Nycticorax nycticorax</i> ... | <i>hoactli</i> ...       | <i>nycticorax</i> ...    | UM, NL         | Ca.         |
| Eastern glossy ibis...       | <i>Plegadis falcinellus</i> ...  | <i>falcinellus</i> ...   | <i>falcinellus</i> ...   | Ca.            | Ca.         |
| Mute swan...                 | <i>Cygnus olor</i> ...           | —                        | —                        | INTR.          | NC          |
| White-fronted goose...       | <i>Anser albifrons</i> ...       | <i>albifrons</i> ...     | <i>albifrons</i> ...     | Ca.            | UM, RW      |
| Brant...                     | <i>Branta bernicla</i> ...       | <i>hrola</i> ...         | <i>hrola</i> ...         | Ca.            | CM, CW      |
|                              |                                  |                          | <i>bernicla</i> ...      |                | CM, CW      |
| Barnacle goose...            | <i>Branta leucopsis</i> ...      | —                        | —                        | ?Ca.           | UM, UW      |
| Canada goose...              | <i>Branta canadensis</i> ...     | <i>canadensis</i> ...    | <i>canadensis</i> ...    | UM             | INTR.       |
| Mallard...                   | <i>Anas platyrhynchos</i> ...    | <i>platyrhynchos</i> ... | <i>platyrhynchos</i> ... | CM, NR         | NC, MC, WC  |
| Blue-winged teal...          | <i>Anas discors</i> ...          | —                        | —                        | CM, NL         | Ca.         |
| Green-winged teal...         | <i>Anas crecca</i> ...           | <i>crecca</i> ...        | <i>crecca</i> ...        | Ca.            | NL, CM      |
|                              |                                  | <i>carolinensis</i> ...  | —                        | CM             |             |
| Pintail...                   | <i>Anas acuta</i> ...            | <i>teiseihoo</i> ...     | <i>acuta</i> ...         | CM, NR         | NL, CM      |
| European widgeon...          | <i>Anas penelope</i> ...         | —                        | —                        | VRM            | NR, CM      |
| Gadwall...                   | <i>Anas strepera</i> ...         | —                        | —                        | UM             | NR, UM      |
| Shoveller...                 | <i>Spatula clypeata</i> ...      | —                        | —                        | UM, NR         | NC, CM      |
| Greater scaup...             | <i>Aythya marila</i> ...         | <i>nearctica</i> ...     | <i>marila</i> ...        | VR             | CW, RS      |
| Golden-eye...                | <i>Bucephala clangula</i> ...    | <i>americana</i> ...     | <i>clangula</i> ...      | UM, WRes.      | CM, CW      |
| Old-squaw...                 | <i>Clangula hyemalis</i> ...     | —                        | —                        | VUM            | CW, US      |
| Eider...                     | <i>Somateria mollissima</i> ...  | <i>dresseri</i> ...      | <i>mollissima</i> ...    | Ca.?           | NCL, CM, CW |
| King eider...                | <i>Somateria spectabilis</i> ... | —                        | —                        | VR             | CaW         |
| White-winged scoter...       | <i>Melanitta fusca</i> ...       | <i>deglandi</i> ...      | <i>fusca</i> ...         | UM             | CM, CW      |
| Goosander (Am. merganser)... | <i>Mergus merganser</i> ...      | <i>americanus</i> ...    | <i>merganser</i> ...     | CM, CW         | NL, CW      |
| Red-breasted merganser...    | <i>Mergus serrator</i> ...       | —                        | —                        | CM             | NC, CM, CW  |
| Osprey...                    | <i>Pandion haliaetus</i> ...     | <i>carolinensis</i> ...  | <i>haliaetus</i> ...     | UM, NR         | UM, NR?     |
| Goshawk...                   | <i>Accipiter gentilis</i> ...    | <i>atricapillus</i> ...  | <i>gentilis</i> ...      | RM, RW         | NU, Res.    |
|                              |                                  |                          | <i>buteoides</i> ...     |                | UM, UW      |
| Rough-legged hawk...         | <i>Buteo lagopus</i> ...         | <i>s. johannis</i> ...   | <i>lagopus</i> ...       | UWRes.         | CM, CW      |
| Golden eagle...              | <i>Aquila chrysaetos</i> ...     | <i>canadensis</i> ...    | <i>chrysaetos</i> ...    | RWRes.         | UW          |
| Marsh hawk...                | <i>Circus cyaneus</i> ...        | <i>hudsonius</i> ...     | <i>cyaneus</i> ...       | CM, NL, CWRes. | CM, NRL, UW |
| Gyr Falcon...                | <i>Falco rusticolus</i> ...      | <i>obsoletus</i> ...     | <i>rusticolus</i> ...    | 1Rec.          | RW          |
| Peregrine falcon...          | <i>Falco peregrinus</i> ...      | <i>anatum</i> ...        | <i>peregrinus</i> ...    | RM, VRWRes.    | NLR, CM, CW |
| Merlin...                    | <i>Falco columbarius</i> ...     | <i>columbarius</i> ...   | <i>acesalon</i> ...      | RM, VRWRes.    | UM, RS      |

\* In American literature the loons are called Cavia.

Table II—(Continued)

| COMMON NAME                         | SCIENTIFIC NAME                           | SUBSPECIES IN              |                                              | OCCURRENCE IN  |                   |
|-------------------------------------|-------------------------------------------|----------------------------|----------------------------------------------|----------------|-------------------|
|                                     |                                           | Ohio                       | Denmark                                      | Ohio           | Denmark           |
| American kestrel.....               | <i>Falco sparverius</i> .....             | <i>sparverius</i> .....    | <i>sparverius</i> .....                      | CRes.          | Ca.               |
| Partridge.....                      | <i>Perdix perdix</i> .....                | <i>perdix</i> .....        | <i>perdix</i> .....                          | INTR.          | CRes.             |
| Pheasant.....                       | <i>Phasianus colchicus</i> .....          | mixed<br>population        | mixed<br>population                          | INTR.          | INTR.             |
| Moorhen (gallinule).....            | <i>Gallinula chloropus</i> .....          | <i>cachinnans</i> .....    | <i>chloropus</i> .....                       | UM, NL         | NC, UM            |
| Black-bellied plover.....           | <i>Squatarola squatarola</i> .....        | —                          | —                                            | UM             | CM                |
| Semipalmated plover.....            | <i>Charadrius hiaticula</i> .....         | <i>semipalmatus</i> .....  | <i>hiaticula</i> .....                       | UM             | NC, CM            |
| Upland plover.....                  | <i>Bartramia longicauda</i> .....         | —                          | —                                            | UM, NL         | Ca.               |
| Hudsonian curlew<br>(whimbrel)..... | <i>Numenius phaeopus</i> .....            | <i>hudsonicus</i> .....    | <i>phaeopus</i> .....                        | RM             | CM, US            |
| Lesser yellow-leg.....              | <i>Tringa flavipes</i> .....              | —                          | —                                            | CM             | Ca.               |
| Ruddy turnstone.....                | <i>Arenaria interpres</i> .....           | <i>morinella</i> .....     | <i>interpres</i> .....                       | VUM            | NL, UM            |
| Long-billed<br>dowitcher.....       | <i>Macrorhamphus<br/>griseus</i> .....    | <i>scolopaceus</i> .....   | <i>scolopaceus</i> .....                     | VRM            | Ca.               |
| Wilson's snipe.....                 | <i>Capella gallinago</i> .....            | <i>delicata</i> .....      | <i>gallinago</i> .....                       | CM             | NC, CM, UW        |
| Sanderling.....                     | <i>Crocethia alba</i> .....               | —                          | —                                            | UM             | UM, RW            |
| Knot.....                           | <i>Calidris canutus</i> .....             | <i>rufus</i> .....         | <i>canutus</i> .....                         | RM             | CM, RS            |
| Purple sandpiper.....               | <i>Calidris maritima</i> .....            | <i>maritima</i> .....      | <i>maritima</i> .....                        | VRM            | UM, UW            |
| Red-backed<br>sandpiper.....        | <i>Calidris alpina</i> .....              | <i>pacifica</i> .....      | <i>schinzii</i> .....<br><i>alpina</i> ..... | UM             | NCL, CM<br>CM, RW |
| Buff-breasted<br>sandpiper.....     | <i>Tryngites<br/>subruficollis</i> .....  | —                          | —                                            | VRM            | Ca.               |
| Ruff.....                           | <i>Philomachus pugnax</i> .....           | —                          | —                                            | 2 Rec.         | NLC, CM           |
| Red phalarope.....                  | <i>Phalaropus fulicarius</i> .....        | —                          | —                                            | Ca.            | VRM, VRW          |
| Northern phalarope.....             | <i>Phalaropus lobatus</i> .....           | —                          | —                                            | VRM            | UM, RW            |
| Northern skua.....                  | <i>Stercorarius skua</i> .....            | <i>skua</i> .....          | <i>skua</i> .....                            | Ca.            | Ca.               |
| Pomarine jaeger.....                | <i>Stercorarius<br/>pomarinus</i> .....   | —                          | —                                            | Ca.            | UM                |
| Parasitic jaeger.....               | <i>Stercorarius<br/>parasiticus</i> ..... | —                          | —                                            | VR             | UM, RS            |
| Long-tailed jaeger.....             | <i>Stercorarius<br/>longicaudus</i> ..... | <i>longicaudus</i> .....   | <i>longicaudus</i> .....                     | 1 Rec.         | UM                |
| Herring gull.....                   | <i>Larus argentatus</i> .....             | <i>smithsonianus</i> ..... | <i>argentatus</i> .....                      | NL, CM, UWRes. | NC, CM, CW        |
| Great black-backed<br>gull.....     | <i>Larus marinus</i> .....                | —                          | —                                            | Ca.            | NL, CW            |
| Glaucous gull.....                  | <i>Larus hyperboreus</i> .....            | <i>hyperboreus</i> .....   | <i>hyperboreus</i> .....                     | Ca.            | UW                |
| Iceland gull.....                   | <i>Larus glaucoides</i> .....             | —                          | —                                            | VR             | Ca.               |
| Kittiwake.....                      | <i>Rissa tridactyla</i> .....             | <i>tridactyla</i> .....    | <i>tridactyla</i> .....                      | Ca.            | NL, USW           |
| Sabine's gull.....                  | <i>Xema sabini</i> .....                  | —                          | —                                            | Ca.            | Ca.               |
| Black tern.....                     | <i>Chlidonias niger</i> .....             | <i>surinamensis</i> .....  | <i>niger</i> .....                           | UM, NLC        | NLC, RM           |
| Gull-billed tern.....               | <i>Gelochelidon nilotica</i> .....        | <i>arvensis</i> .....      | <i>nilotica</i> .....                        | ?              | NL, RS            |
| Caspian tern.....                   | <i>Hydroprogne tshengra</i> .....         | —                          | —                                            | UM             | NCa.?, RM         |
| Common tern.....                    | <i>Sterna hirundo</i> .....               | <i>hirundo</i> .....       | <i>hirundo</i> .....                         | CM, NL         | NC, CM            |
| Roseate tern.....                   | <i>Sterna dougallii</i> .....             | <i>dougallii</i> .....     | <i>dougallii</i> .....                       | Ca.            | Ca.               |
| Least tern.....                     | <i>Sterna albifrons</i> .....             | <i>antillarum</i> .....    | <i>albifrons</i> .....                       | VR             | NLC, RM           |
| Brunnich's murre.....               | <i>Uria lomvia</i> .....                  | <i>lomvia</i> .....        | <i>lomvia</i> .....                          | Ca.            | UW                |
| Yellow-billed cuckoo.....           | <i>Coccyzus americanus</i> .....          | <i>americanus</i> .....    | <i>americanus</i> .....                      | CM, NL         | Ca.               |
| Barn owl.....                       | <i>Tyto alba</i> .....                    | <i>pratensis</i> .....     | <i>guttata</i> .....                         | URes.          | NC, Res.          |
| Snowy owl.....                      | <i>Nyctea scandiaca</i> .....             | —                          | —                                            | UWRes.         | UWRes.            |
| Hawk owl.....                       | <i>Surnia ulula</i> .....                 | <i>caparoch</i> .....      | <i>ulula</i> .....                           | R, VRN         | RW                |
| Long-eared owl.....                 | <i>Asio otus</i> .....                    | <i>wilsonianus</i> .....   | <i>otus</i> .....                            | R, VRN         | NC, UM, UW        |
| Short-eared owl.....                | <i>Asio flammeus</i> .....                | <i>flammeus</i> .....      | <i>flammeus</i> .....                        | UM, VRN        | NLC, UM           |
| Horned lark.....                    | <i>Eremophila alpestris</i> .....         | <i>pratensis</i> .....     | <i>flava</i> .....                           | CM, CN         | UM, UW            |
| Barn swallow.....                   | <i>Hirundo rustica</i> .....              | <i>erythrogaster</i> ..... | <i>rustica</i> .....                         | CWRes.         | NC, CM            |
| Bank swallow.....                   | <i>Riparia riparia</i> .....              | <i>riparia</i> .....       | <i>riparia</i> .....                         | VCM, CN        | NC, CM            |
| Raven.....                          | <i>Corvus corax</i> .....                 | <i>principalis</i> .....   | <i>corax</i> .....                           | Ext.           | NL, Res.          |

Table II—(Continued)

| COMMON NAME                 | SCIENTIFIC NAME                      | SUBSPECIES IN             |                                      | OCCURRENCE IN |                     |
|-----------------------------|--------------------------------------|---------------------------|--------------------------------------|---------------|---------------------|
|                             |                                      | Ohio                      | Denmark                              | Ohio          | Denmark             |
| Magpie.....                 | <i>Pica pica</i> .....               | <i>hudsonia</i> .....     | <i>pica</i> .....                    | Ca.           | NC, Res.            |
| Black-capped chickadee..... | <i>Parus atricapillus</i> .....      | <i>atricapillus</i> ..... | <i>salicarius</i> .....              | URes.         | VR?                 |
| Brown creeper.....          | <i>Certhia familiaris</i> .....      | <i>americana</i> .....    | <i>macrodactyla familiaris</i> ..... | CM, UWRes.    | NC, Res.<br>NLC, UW |
| Winter wren.....            | <i>Troglodytes troglodytes</i> ..... | <i>hiemalis</i> .....     | <i>troglodytes</i> .....             | CM, UWRes.    | NC, CM, CW          |
| Water pipit.....            | <i>Anthus spinoletta</i> .....       | <i>rubescens</i> .....    | <i>littoralis</i> .....              | CM            | NL, CM              |
| Waxwing.....                | <i>Bombycilla garrulus</i> .....     | <i>pallidiceps</i> .....  | <i>garrulus</i> .....                | VRWRes.       | CW                  |
| Northern shrike.....        | <i>Lanius excubitor</i> .....        | <i>borealis</i> .....     | <i>excubitor</i> .....               | VRWRes.       | NL, CM, CW          |
| Starling.....               | <i>Sturnus vulgaris</i> .....        | <i>vulgaris</i> .....     | <i>vulgaris</i> .....                | INTR.         | NC, CM              |
| House sparrow.....          | <i>Passer domesticus</i> .....       | <i>domesticus</i> .....   | <i>domesticus</i> .....              | INTR.         | NC, Res.            |
| Redpoll.....                | <i>Carduelis flammea</i> .....       | <i>linaria</i> .....      | <i>flammea</i> .....                 | VRWRes.       | CM, CW              |
|                             |                                      |                           | <i>holboellii</i> .....              |               | UW                  |
|                             |                                      | <i>exilipes</i> .....     | <i>exilipes</i> .....                | Ca.           | Ca.                 |
| Pine grosbeak.....          | <i>Pinicola enucleator</i> .....     | <i>leucura</i> .....      | <i>enucleator</i> .....              | Ca.           | RW                  |
| Red crossbill.....          | <i>Loxia curvirostra</i> .....       | <i>pusilla</i> .....      | <i>curvirostra</i> .....             | VRWRes.       | NU, UM              |
| White-winged crossbill..... | <i>Loxia leucoptera</i> .....        | <i>leucoptera</i> .....   | <i>bifasciata</i> .....              | VRWRes.       | UW                  |
| Lapland longspur.....       | <i>Calcarius lapponicus</i> .....    | <i>lapponicus</i> .....   | <i>lapponicus</i> .....              | RWRes.        | UW                  |
| Snow bunting.....           | <i>Plectrophenax nivalis</i> .....   | <i>nivalis</i> .....      | <i>nivalis</i> .....                 | RWRes.        | CM, CW              |

The remaining 93 species can roughly be divided up into six groups:

1. Species that are rare and casual in both areas, occurring as transients or visitors: Leach's petrel, Eastern glossy ibis, king eider, golden eagle, gyrfalcon, long-billed dowitcher, sanderling, buff-breasted sandpiper, red phalarope, northern skua, Iceland gull, Sabine's gull, roseate tern, snowy owl, pine grosbeak.

Of the 16 species rare in both countries almost all of them are occasional stragglers from the north, exceptions are Eastern glossy ibis and roseate tern. Eleven of them are water birds.

2. Species that occur in small numbers, scarce or irregular in both areas are: Common loon, and Caspian tern, of which the latter is an irregular breeding bird in Denmark, breeding with an interval of many years. Both are northern species.

3. Species that are rare in the one and scarce or irregular in the other area.

Species rare in Ohio, and scarce or irregular but more numerous in Denmark are: Gannet, white-fronted goose, barnacle goose, merlin, purple sandpiper, northern phalarope, pomarine jaeger, parasitic jaeger, long-tailed jaeger, glaucous gull, Brunnich's murre, white-winged crossbill and Lapland longspur.

These 13 species are all more northern breeding species; the European gannets do, however, breed as far south as Wales in England. Ten of the species are water birds.

4. Species rare in the one and common transients in the other area.

Species rare in Ohio, common  
in Denmark:

Rough-legged hawk  
Black-bellied plover  
Hudsonian curlew (whimbrel)  
Knot  
Bohemian waxwing  
Redpoll  
Snow bunting

Species rare in Denmark,  
common in Ohio:  
Lesser yellow-leg "

Of the eight species in this group, seven, namely, those rare in Ohio, but common in Denmark, are northern species; three of them are water birds. The bird rare in Denmark and common in Ohio, the lesser yellow-leg, is an occasional straggler across the Atlantic.

5. Species breeding in one country, but not in the other.

Species breeding in Denmark,

and not in Ohio:

Eared grebe  
Green-winged teal  
European widgeon  
Gadwall  
Eider  
Goosander (Amer. merganser)  
Red-breasted merganser  
Goshawk  
Peregrine falcon  
Semipalmated plover  
Ruddy turnstone  
Wilson's Snipe<sup>2</sup>  
Red-backed sandpiper  
Ruff  
Great black-backed gull  
Kittiwake  
Gull-billed tern  
Least tern  
Raven  
Magpie  
Brown creeper  
Winter wren  
Water pipit  
Northern shrike  
Red crossbill

Species breeding in Ohio,

and not in Denmark:

Black-crowned night heron  
Blue-winged teal  
Osprey  
American kestrel  
Upland plover  
Yellow-billed cuckoo  
Horned lark  
Black-capped chickadee

An analysis of the above data shows that all of the 25 species, which are breeding birds in Denmark, but only transients or occasional visitors in Ohio (raven has been exterminated in Ohio), are without exception, northern species; 16 of them are water or wading birds.

Of the eight species recorded in, but not breeding in Denmark, four are occasional stragglers from North America, namely, blue-winged teal, American kestrel, upland plover and yellow-billed cuckoo, and each of them only recorded once in Denmark. The black-crowned night-heron occurs as an occasional visitor from southern Europe; the Scandinavian horned larks breed much farther north, namely, on the tundras and mountain plateaus of the Scandinavian peninsula (the complete difference in habitat and ecological requirements of Scandinavian and North American horned larks is so striking that a study of the subject might be worth while). Concerning the remaining two species, the osprey formerly bred commonly in Denmark, but is now exterminated; maybe one or a few pairs are still found; the subspecies of the black-capped chickadee is moving up into Denmark from the South, and is suggested as a possible breeding bird in southernmost Denmark (Löppenthin, 1946).

6. Species breeding in both countries are: Mallard, pintail, shoveller, marsh hawk, gallinule, herring gull, black tern, common tern, barn owl, long-eared owl, short-eared owl, barn swallow, bank swallow.

With the exception of the marsh hawk, of which family two other species are more common breeding birds in Denmark, all of the species mentioned in this group are common breeding birds

<sup>2</sup>Listed by Trautman (1935: 7) as common migrant only. Hicks (1935: 152) lists it as a breeding bird in three northeastern counties, but says the "species is likely to disappear as a breeding bird within a few years."

in Denmark, whereas in Ohio only a few of them are so widely distributed in the state that they may be called common.

Mallard, pintail, shoveller, herring gull, black tern and common tern are restricted to a few areas along or in Lake Erie; marsh hawk, gallinule, long-eared owl, and bank swallow are mostly found in the northern part of the state; short-eared owl scattered, but mostly in the northern part; barn owl over most of the state, but most common in the southern part of the state; barn swallow is found all over the state of Ohio. Six of the 13 species are water birds.

#### POSSIBLE REASONS FOR SIMILARITIES AND DIFFERENCES IN AVIFAUNAS

What conclusions may be derived from the above given data concerning composition, quantity, and reasons for differences in the avifaunas of these two remote areas? First, let us consider the number of species recorded. It is striking to see that Denmark, even if it is much smaller in area, has a list of species almost as long as that for Ohio (resp. 334 and 343). If the number of species recorded were in the same proportion to a unit of land as in Denmark, there should have been 831 species recorded from Ohio. Conversely, if the number of birds decreased in proportion to the unit of land there should only have been 138 species recorded from Denmark, which is less than the number of regular breeding birds in the country. Interpretation of the foregoing statements should not be misconstrued. It is not meant that the number of bird species within an area is proportional to the size of the area. Many other factors such as variety of habitats, geographical location, isolation, climate and vegetation are of much importance in this respect. Rather, it is the author's contention to point out the fact that more species could be expected from Ohio if its geographical location were similar to that of Denmark's. The land areas of Ohio and Denmark are respectively 41,222 and 16,576 square miles.

How does this diversity come about?

The reasons may be listed as follows:

(a) Denmark is the apex of the European continent and as such the connecting link (flyways and migration routes) between middle and western Europe and Fenno-Scandia-Siberia, as well as many northern birds winter in Denmark.

(b) Denmark is an archipelago consisting of one peninsula and 483 islands, thus getting its share of migrating and wandering around water birds.

(c) Denmark, because of its position between southern and northern faunas, gets its share of both faunas, further occasional visits of southern birds, and all northern migrants.

(d) Denmark has a diversity in vegetation, landscape form, and land-use not found in Ohio.

#### (a) *Denmark as the apex of the European Continent*

The importance of peninsulas and islands as migration routes of birds has been known for a long time.

Denmark's geographical position as an apex of the European continent, with the Jutland peninsula protruding north from the continent and the islands extending eastward to the southern part of Sweden, makes the country a natural bridge for many of the birds coming from northern Scandinavia and Siberia.

Salomonson (1938: 36) mentions how the ducks wintering in England were shown by banding to come from Denmark, Sweden, Finland, western Russia, Balticum, most of these birds migrating in a southwesterly direction over Denmark. Blume and Frölich (1946) have recently shown how a great part of Scandinavian birds-of-prey migrate over the eastern part of Denmark.

Many of the birds coming from the North winter in Denmark. These include especially diving ducks in the seas around the country, but also loons, swans, certain birds-of-prey, and a few passerines, as the dipper, *Cinclus cinclus*, brambling, *Fringilla montifringilla* and snow-bunting, *Plectorphenax nivalis*.

The migration of many species, (one good example is the wood cock, *Scolopax*

*rusticola*), takes place from Jutland over Skagerrak to southern Norway or over Kattegat to Sweden. These birds thus migrate over a broad front, and during the migration seasons are found over nearly the whole country in suitable habitats. Others, as the above mentioned birds-of-prey, follow the eastern part of Sjælland and the smaller islands south of it. As indicated by Holm (1940), ducks (especially diving ducks), breeding in the Baltic Sea and the Gulf of Bothnia, migrate along the eastern shores of Sweden and enter Danish waters around the southern tip of Sweden.

As a matter of interest it should be pointed out that the Zoological Museum of Københavns Universitet has an agreement with the personnel of the Danish light-houses that all birds killed by flying against the light-houses and found at the light-houses are to be turned in to the museum. A great number of birds are secured annually this way. It might also be mentioned that duck traps were legal up to 1931. In one of these, on the island of Fanø off the west coast of Jutland, 3100 ducks were caught annually from 1900–1927 (Weismann, 1939: 267), indicating the number of ducks passing by.

One difference between Ohio and Denmark is that Ohio as part of a vast continent, and without outstanding features of any kind to attract migrating birds, only gets a relatively small share of migrating birds, mostly land birds and birds migrating over a broad front, whereas Denmark lies on the direct migration routes and is passed by almost all of the birds migrating to or from Norway and Sweden, and also many birds from Finland, northern and western Russia and Balticum.

#### (b) *Denmark as an Archipelago*

A comparison of the data in Table 2 and the other information given above shows that Denmark is ahead of Ohio concerning the frequency in which the different species in common occur, and further, that out of the 99 species, 63 (64 per cent) are water or wading birds, and of these 63 species 28 are more common in Denmark than in Ohio, and 15 of them breed in Denmark and not in Ohio.

The difference in composition in the avifaunas will also appear from a consideration of the total number of birds listed for the two areas.

Of Ohio's 343 species, 134 (39 per cent) are water or wading birds, of which 27 (20 per cent) do breed in Ohio.

Of Denmark's 334 species, 153 (46 per cent) are water or wading birds of which 65 (42 per cent) do breed in Denmark, most of them abundantly.

There can also be no doubt that several of the species which have occurred as occasional visitors in Denmark have come to the country because of its geographical position in the sea.

Good examples, for upholding this hypothesis, are some of the stragglers from North America: Blue-winged teal, lesser yellow-leg, and buff-breasted sandpiper, three species which undoubtedly never would have reached Denmark were it not for its location and connection with the Atlantic Ocean.

It is also characteristic that where, e.g., the lesser yellow-leg has occurred in Europe in addition to the Danish record it has been in countries with a seashore, namely, nine records from the British Isles, and it has also been recorded from Holland (Hörring, 1942: 45).

As another indicator of the importance of the surrounding sea the following might be mentioned. From the area around Herning in the heart of Jutland, 54 km. to the North Sea and one of the places in Denmark farthest away from the sea, Overgaard (1932) mentions 143 species of birds observed. Wittrup Jensen (1937) observed 105 species of birds in Fyn, on a farm 4 km. from the shore of the Great Belt. In contrast to this, Harboe (1939) observed 173 species at Præstø, at the seashore; and I have observed 194 species in my home region at Vejle, Vejle Fjord. It is characteristic, too, that the birds that are lacking in making up the greater species list in the inland areas are water and shore birds.

An illustration of the importance and abundance of the water bird group is also given in the annual kill records collected by the Danish Game Department.

The latest figures are from 1945 (Dansk Jagttidende, 64: 138), and show that the total kill of waterfowl, sea and shore birds for that year was:

|         |                      |
|---------|----------------------|
| 371,674 | pond ducks           |
| 130,551 | diving ducks         |
| 9,814   | geese                |
| 79,875  | gulls                |
| 20,906  | other swimming birds |
| 27,950  | wood cocks           |
| 41,282  | snipes               |
| 28,508  | curlews              |
| 2,605   | herons               |
| 20,684  | other shore birds    |

In all, 1,033,849 waterfowl, sea and shore birds were shot, most of which are good eatable game birds.

Comparable figures are unfortunately not available for Ohio, but the number of waterfowl shot is much less, and shore birds are not legal game birds in Ohio. Daniel L. Leedy's figures (1947: 5) show that 2.03 per cent of Ohio's total game kill is ducks, 0.05 per cent geese, and 0.3 per cent coots, waterfowl and other water birds in all comprising 2.38 per cent of the total game kill in Ohio, whereas this group of birds in Denmark comprises 54 per cent of the eatable game killed. In Ohio there was 0.26 duck shot per hunter, whereas in Denmark there were 5.5 duck shot per hunter, or 22 times more ducks shot per hunter in Denmark than in Ohio.

(c) *Ohio and Denmark as border areas  
between North and South*

To some extent Ohio and Denmark occupy similar positions as border areas between north and south, both areas getting a fair share of the northern and southern bird elements. Very few of these northern birds, however, breed in Ohio, whereas many breed in Denmark; these species are listed in group 5, p. 23.

A comparison of the groups of birds listed, pp. 20-22, will show how most of the birds in common for Ohio and Denmark are most common in Denmark, and the ones that are not are mostly birds native of the North American Continent and so stragglers to Denmark.

Examples of some northern species that breed in Denmark, but only occur occasionally in Ohio, are eider, goosander (Am. merganser), goshawk, peregrine falcon, kittiwake, raven, magpie, northern shrike, and red crossbill.

Of the birds in common for the two areas, Ohio has the black-crowned night heron as a common breeding bird in suitable habitats; this bird is a southern species, and has only been recorded a few times from Denmark as a straggler from breeding colonies in southern Europe or Africa.

Other species, not found in Denmark, add much more to the southern character of Ohio's bird fauna, especially the New World birds: hummingbirds, and also the vultures. Vultures are found in southern Europe and Africa, from where three species (*Aegypius monachus*, *Gyps fulvus*, and *Neophron percnopterus*) have straggled to Denmark, a total of six individuals having been recorded from the country (Hörring, 1934).

Species, such as many New World warblers, *Parulidae*, the various *Icteridae*, tanagers, *Thraupidae* and others, add still more to the southern characterized bird fauna of Ohio. Above all, the ruby-throated hummingbird, *Archilochus colubris*, is the sensation for the ornithologist from a nordic country.

The glossy ibis, which in North America breeds in peninsular Florida, and in

Europe in the Lower Danube valley, South Spain and South Russia, has been recorded in both Denmark and Ohio also.

(d) *The diversity in landscape, vegetation  
and land-use in Denmark*

A very important factor for the large number of birds found in Denmark is the diversity of the Danish landscape.

Roughly speaking, Ohio consists of the flat western farm land part and the hilly eastern dairy section and southern forest land. In addition, the Lake Erie shoreline, rivers, lakes, and ponds add to its varying landscape.

In spite of its smallness Denmark shows a more varied type of landscape, including a long sea-shoreline (4,622 miles); a large number of islands in the sea of which 383 are uninhabited, and many of them rocky; long, narrow fjords; a great number of streams, creeks and brooks, ponds and lakes; vast marsh lands; sand-dunes; large closed and open bays; moorlands and heath; great pine and spruce forests in addition to deciduous forests; and farmland with many fencerows and windbreaks.

The importance of Denmark's location in the sea has been discussed above.

The long sea-shore affords habitat for a variety of birds, on the sand strand itself breed the least tern, semipalmated plover, oyster-catcher and others; on the adjoining strand meadows a great many birds may be found breeding: gulls, terns, ducks and shore birds.

The islands are often densely populated with birds: gulls, terns, ducks and shore birds. On rocky islands breed eiders, turnstones, kittiwakes, murres, razor-billed auks and black guillemots. Along the fjords are sometimes found strand meadows with suitable habitats for waterfowl and shore birds; and the fjords are often a preferred wintering area for diving ducks, loons and gulls.

Ponds and lakes harbor waterfowl and shore birds; marsh lands the same variety of species plus others as various harriers, bitterns and godwits. In not too wet marsh lands the short-eared owls occur.

The sand-dunes have a very characteristic flora, but bird life is scarce, wheatears, *Oenanthe oenanthe*, being one species that commonly is found there, in addition to gulls and terns from the nearby sea.

The heath, occupying 7.5 per cent of the total land area, is a very characteristic type of land with a very distinct flora and fauna. Birds characteristic of the heath are the golden plover, black grouse, *Lyrurus tetrrix*; and wood sandpiper, *Tringa glareola*, in the wetter parts. Since 1930 the curlew, *Numenius arquata*, has started breeding in increasing numbers (Westerskov, 1942 a), and seems to take over certain heaths after the plover that has decreased in number.

Since about 1870 increased plantings of conifers have been made because of the high prices for softwood. These plantings have resulted in a rapid increase in coniferous forest lands. Newcomers to these plantations are the crested tit, *Parus cristatus*, which immigrated to Denmark as a breeding bird in the last decade of the 19th century, and since has spread to plantations all over Jutland (Jespersen, 1944); mistle thrush, *Turdus viscivorus*, red crossbill, *Loxia curvirostra*, green woodpecker, Montagu's harrier, *Circus pygargus*, European woodcock, and others (Poulsen, 1947).

Concerning land-use methods, the extensive use of fencerows and windbreaks especially, is of great benefit to the bird life in Denmark. The fencerows furnish shelter, nesting sites and food for a great variety of Passerines. The influence of fencerows on the number of birds present will be discussed further in another paper.

Ohio does not offer the variety of habitats found in Denmark. The number of birds found in the farm land section is lower because of lack of fencerows for shelter and nesting sites. The intensive farming of vast areas of the same crop

does not yield the variety of food and nesting sites as the smaller, often irregular shaped Danish fields.

#### CLOSELY RELATED SPECIES IN ADDITION TO IDENTICAL ONES

In addition to the species, mentioned in Table 2, that have been recorded from both Ohio and Denmark, a number of other birds, very much alike in general appearance, are found in both areas.

Many of the species I refer to here are so much alike that they can not be told apart when seen in the field, as e.g., the American great blue heron, *Ardea herodias*, and the European common heron, *Ardea cinerea*. Others, as e.g., the blue jay, *Cyanocitta cristata*, and the European jay, *Garrulus glandarius*, behave and act alike, live in comparable habitats, are shaped alike, and their voices are much alike, but they vary somewhat in size and color.

These species, that are listed in Table 3, contribute probably almost as much to the similarity of Ohio and Denmark avifaunas as all of the 99 identical species lumped together. Many of the birds of this group are common breeding birds in both areas, whereas only a very few of the identical species, listed in Table 2, do breed commonly in both regions.

A matter like this can only be based on a personal estimate of which birds appear alike to the observer. The following list is proposed as such a list, with all the limitations such a list may have.

TABLE III  
CLOSELY RELATED BIRD SPECIES FOUND IN OHIO AND DENMARK  
Key symbols as in Table I

| OHIO                                                 |            | DENMARK                                                |             |
|------------------------------------------------------|------------|--------------------------------------------------------|-------------|
| NAME                                                 | OCCURRENCE | NAME                                                   | OCCURRENCE  |
| Great blue heron, <i>Ardea herodias</i> .....        | CM, NL     | Common heron, <i>Ardea cinerea</i> .....               | CM, NC      |
| Am. bittern, <i>Bolaurus lentiginosus</i> .....      | CM, NL     | Eur. bittern, <i>Bolaurus stellaris</i> .....          | NL          |
| Redhead, <i>Nyroca americana</i> .....               | UM         | Pochard, <i>Nyroca ferina</i> .....                    | NLC, CM     |
| Sharpshinned hawk, <i>Accipiter velox</i> .....      | UM, RN     | Sparrow hawk,† <i>Accipiter nisus</i> .....            | NC, CM      |
| Redtailed hawk, <i>Buteo borealis</i> .....          | UWRes, RN  | Buzzard, <i>Buteo buteo</i> .....                      | NC, CM      |
| Bald eagle,* <i>Haliaeetus leucocephalus</i> .....   | RWRes, VRN | Sea eagle, <i>Haliaeetus albicilla</i> .....           | EN, UW      |
| Virginia rail, <i>Rallus limicola</i> .....          | UM, NL     | Water rail, <i>Rallus aquaticus</i> .....              | NL, CM      |
| Sora, <i>Porzana carolina</i> .....                  | NL, CM     | Spotted crane, <i>Porzana porzana</i> .....            | NL, UM      |
| American coot,* <i>Fulica americana</i> .....        | CM, NL     | Coot, <i>Fulica atra</i> .....                         | NC, CM      |
| Golden plover, <i>Pluvialis dominica</i> .....       | UM         | Golden plover, <i>Pluvialis apricaria</i> .....        | NL, CM      |
| Woodcock, <i>Philohela minor</i> .....               | UM, NL     | Woodcock, <i>Scolopax rusticola</i> .....              | NL, CM      |
| Am. Avocet,* <i>Recurvirostra americana</i> .....    | Ca.        | Avocet, <i>Recurvirostra avocetta</i> .....            | NCL         |
| Bonaparte's gull, <i>Larus philadelphia</i> .....    | CM         | Black-headed gull, <i>Larus ridibundus</i> .....       | CW, NC, CM  |
| Ring-billed gull, <i>Larus delawarensis</i> .....    | CM, UWRes  | Common gull, <i>Larus canus</i> .....                  | NC, CM, CW  |
| Great horned owl, <i>Bubo virginianus</i> .....      | URes       | Great horned owl, <i>Bubo bubo</i> .....               | EN, RW      |
| Barred owl, <i>Strix varia</i> .....                 | URes       | Tawny owl, <i>Strix aluco</i> .....                    | NC, Res     |
| Whip-poor-will, <i>Caprimulgus vociferus</i> .....   | NL, CM     | Nightjar, <i>Caprimulgus europaeus</i> .....           | NCL, UM     |
| Chimney swift, <i>Chaetura pelagica</i> .....        | NL, CM     | Swift, <i>Apus apus</i> .....                          | NC, CM      |
| Hairy woodpecker, <i>Dryobates villosus</i> .....    | CRes       | Great spotted woodpecker, <i>Dryobates major</i> ..... | NC, Res     |
| Crow,* <i>Corvus brachyrhynchos</i> .....            | VCM, CN    | Crow, <i>Corvus corone</i> .....                       | NC, CM, CW  |
| Blue jay, <i>Cyanocitta cristata</i> .....           | CRes       | Jay, <i>Garrulus glandarius</i> .....                  | NC, CM      |
| Whitebr. nuthatch, <i>Sitta carolinensis</i> .....   | CRes       | Nuthatch, <i>Sitta europaea</i> .....                  | NC, Res     |
| Wood thrush, <i>Hylocichla ustulata</i> .....        | CM, NL     | Song thrush, <i>Turdus ericetorum</i> .....            | NC, CM      |
| Golden-crowned kinglet, <i>Regulus satrapa</i> ..... | CM, UWRes  | Goldcrest, <i>Regulus regulus</i> .....                | NC, Res, CM |
| Eastern phoebe, <i>Sayornis phoebe</i> .....         | NC, CM     | Spotted flycatcher, <i>Muscicapa striata</i> .....     | CN, CM      |
| Pine siskin, <i>Spinus pinus</i> .....               | UM, RWRes  | Siskin, <i>Carduelis spinus</i> .....                  | NL, CM, CW  |

\*Certain similar American and European species of birds are considered by a group of ornithologists to be races of the same species and could accordingly be listed in Table II. These include, for example: the American bald eagle and European sea eagle, coot, avocet and crow.

† Not to be confused with the American "sparrow hawk:" the Am. kestrel, *Falco sparverius*.

It is obvious, however, that some other species, found in exactly the same habitats, are more or less alike, even if the difference in size or appearance is so great they do not have much similarity in appearance.

These birds, which have what might be called ecological niche similarities, are:

Belted kingfisher, *Megaceryle alcyon* in Ohio and kingfisher, *Alcedo atthis*, in Denmark, both living at streams and lakes, having their nests in a burrowed hole in stream banks.

Flicker, *Colaptes auratus*, in Ohio and green woodpecker, *Picus viridis*, in Denmark, both mature forest species, much alike in behavior, size, flight and screech.

Robin, *Turdus migratorius*, in Ohio and blackbird, *Turdus merula*, in Denmark, both being woods-parks birds, and living in gardens and where possible around human dwellings.

Finally two species may be mentioned which live in the same ecological niches, and playing the same role in people's mind as messengers of spring, namely, the Killdeer, *Charadrius vociferus*, in Ohio fields, and the lapwing, *Vanellus vanellus*, of Danish fields. Where you look for lapwings in the fields of Denmark, you look for killdeer in Ohio.

In order to test my idea about this I asked Dr. Daniel L. Leedy, of the Ohio Wildlife Research Unit, who served in England during the war, what the counterpart of the killdeer was in England. And I got the answer: Lapwing.

#### A GENERAL AVIFAUNISTIC COMPARISON

It is difficult to summarize the heterogenous bulk of information given above. Certain conclusions may be derived, however, concerning similarities in the bird faunas.

The two types of habitats where the greatest similarity is found are urban areas and water areas.

In cities English sparrows and starlings are as common in Ohio as in Denmark, and during the summer time the swifts are seen over Ohio cities as well as over Danish cities.

Lake shores, islands, ponds and streams have, however, the greatest number of similar birds: ducks, gulls, terns, shore birds, coots, gallinules, etcetera.

Farmlands in both areas have the introduced pheasant and the European partridge, whereas most of the other birds found in the fields are different.

Birds of the forests are not much alike, certain birds-of-prey, crows, wrens, kinglets, and others, occur in both areas, some of them in the same species, others belonging to various genera, but yet rather alike.

For convenience in comparing the avifaunas of Ohio and Denmark the birds may be grouped as follows:

- 1) Subspecies that are identical and occupying the same ecological niches, and breeding commonly in both areas, as the introduced sparrows and starlings; other species as mallard and bank swallow.

- 2) Species that are alike, but different subspecies, breed in both areas, as the barn swallow, marsh hawk and gallinule.

- 3) Species that are different (yet much alike in appearance), but belonging to the same genus, occupying the same ecological niches, and breeding in both areas, as the great blue heron, coot, and sharpshinned hawk.

- 4) Species that belong to different genera, but yet are so externally alike that they are easily recognized as "identical" when seen in the field, as the woodcock and chimney swift.

- 5) Species that are definitely different in color pattern or size, but which

occupy the same ecological niches, as the belted kingfisher, flicker and robin in Ohio compared to kingfisher, green woodpecker and blackbird in Denmark.

How similar or dissimilar the general bird picture is will best appear from some examples of birds seen at various seasons and in various habitats in the two areas.

During a trip to the University woodlot, Ohio State University's farm, on April 6, 1947, I saw 21 species of which only two could have been seen on a similar trip in Denmark, namely, English sparrow and starling. Species rather similar to Danish species found in similar habitat, were the kestrel, flicker, phoebe and crow.

During a trip to the forest at Barrit, Vejle Fjord, Denmark, on April 9, 1944, I saw 24 species of which only the starling could have been found in Ohio, too. Species resembling American ones were crow, green woodpecker, great spotted woodpecker, buzzard and sparrow hawk.

On a trip to Starve Island, Lake Erie, June 18, 1947, I found five species breeding on the small island, of which the two, common tern and herring gull, breed in similar habitats in Denmark, and two of the others have "relatives" in similar Danish habitat, namely, the black duck and spotted sandpiper.

On a trip to the island of Langli in Ho Bugt in Denmark, June 4, 1942 (Westerskov, 1942 b), I observed 15 species of birds of which the 14 were breeding. Of these 14 species five could have been found in a similar habitat in Ohio, namely, semipalmated plover, herring gull, common tern, barn swallow, and starling (the last two breeding at the shepherd's house).

These few examples could be supplemented with many more, but they give a little idea about which similar species are seen.

The variety in habitats in the Danish archipelago compared with the more homogeneous look of the state of Ohio as a small part of a vast continent affords possibilities for interesting comparisons in faunistic and floristic fields.

Further studies and comparisons between regions in various parts of the world are suggested, and might yield unexpected results not only concerning ecological compositions and evolution, but might even render a basis for suggestions in applied phases of ecology, as wildlife management, agriculture and forestry.

#### SUMMARY

In spite of various geographical locations and differences in climate, vegetation, landscape form and land-use, the State of Ohio and the Kingdom of Denmark have a certain degree of similarity in avifaunas, especially concerning the water birds: ducks, gulls, terns, etc.

Three hundred and forty-three species of birds have been recorded from Ohio, and 334 from Denmark. Of these no less than 99 species have been recorded in both areas. Sixty-four percent of these are water or wading birds.

Most of the birds recorded from both areas are more common in Denmark than in Ohio. Of the 46 species breeding in either country, 13 breed in both areas, 8 in Ohio only, and 25 in Denmark only.

The main reasons for the proportionately greater number of species in Denmark and greater frequency of those species present are thought to be first, the geographical position of the country as an apex of the European continent, thus being the connecting link (flyway) between western Europe and Fennoscandia-Siberia, and affording wintering grounds for many northern birds, especially diving ducks.

Second, Denmark is an archipelago consisting of one peninsula and 483 islands, thus getting its share of migrating and wandering around water birds.

Third, both areas are more or less intermediate between northern and southern faunas, but Denmark most so.

Finally, there is a diversity in vegetation, landscape form and land-use in Denmark not found in Ohio.

In addition to identical species occurring in the two areas a number of birds are so much alike that often they cannot be identified in the field. Twenty-six such species are listed.

Greatest similarity in the avifaunas are found at lakeshores and seashores, and in towns. Very few birds of field and forest are the same in the two areas.

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# STUDIES IN HUMAN INHERITANCE XXXIV. FURTHER DATA ON THE LINKAGE OF THE GENES FOR SICKLE CELLS AND THE M-N BLOOD TYPES

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The demonstration of linkage between human genes has long been an ideal of laboratories of human genetics. Many studies have been made along this line, mostly with negative results. A few instances of probable linkage have been reported (Penrose, 1935; Haldane, 1936; Burks, 1937; Rife, 1941, Hoogvliet, 1942; Snyder and Palmer, 1943; Kallis and Schweitzer, 1943; Penrose, 1946; Kloepper, 1946), but these have largely involved either sex-linked characters or variable traits, the exact hereditary nature of which is not known. For a comprehensive summary of the linkage studies carried out to date, see Kloepper, 1946.

Recently we presented evidence for the first instance of autosomal linkage involving proved unit factors (Snyder, Russell and Graham, 1947). Both coupling and repulsion phases were demonstrated. This discovery was of sufficient importance to warrant the intensive search for more data. We have therefore concentrated our attention on the obtaining of families showing the sickle cell trait, in which the sickle cell parent was type MN. We have found a number of such families, and some of them are of suitable nature to provide linkage data. The additional families uphold the hypothesis that the genes for sickle cells and for the M-N types are linked, and that the gene for sickle cells is transmitted independently of the genes for the A-B groups and the Rh types.

The complete data, including those of Snyder, Russell and Graham, are presented below. For the association between sickle cells and the M-N types (Table I), the total score (summation of  $\lambda$ ) is seen to be 12.72, with a variance

TABLE I  
LINKAGE DATA ON THE GENES FOR SICKLE CELLS AND THE M-N BLOOD TYPES

| Finney Type | Family Number | a | b | c | d | $\gamma$ | K      |
|-------------|---------------|---|---|---|---|----------|--------|
| 3           | 30            | 2 | 0 | 0 | 0 | 1.00     | 1.000  |
| 4           | 7             | 3 | 0 | 0 | 1 | 6.00     | 6.000  |
| 4           | 8             | 1 | 0 | 0 | 2 | 3.00     | 3.000  |
| 4           | 11            | 1 | 2 | 1 | 0 | 0.00     | 6.000  |
| 4           | 17            | 0 | 1 | 0 | 1 | -1.00    | 1.000  |
| 18          | 37            | 1 | 1 | 1 | 0 | -0.11    | 0.549  |
| 18          | 38            | 1 | 0 | 4 | 1 | -0.78    | 1.987  |
| 18          | 39            | 3 | 0 | 0 | 1 | 3.83     | 0.941  |
| 18          | 40            | 0 | 1 | 2 | 0 | 0.78     | 0.549  |
|             |               |   |   |   |   | 12.72    | 21.026 |

(summation of K) of 21.026. Since the total score exceeds 2.33 times the square root of the variance (12.72 exceeds 10.69), the evidence against the hypothesis of random assortment is significant at the one percent level.

The crossover percentage (c) may be estimated from the formula

$$c = \frac{1}{2} \left( 1 - \sqrt{\frac{\sum \lambda}{\sum K}} \right), \text{ which gives a value of 0.111.}$$

For the record, the corresponding tables for the A-B blood groups and the Rh types are also presented (Tables II and III), indicating the independent transmission of these genes and the gene for sickle cells. In neither case does the total score even approach the square root of the variance.

Finney's modifications of Fisher's methods were used throughout the analyses (Finney, 1940).

TABLE II  
LINKAGE DATA ON THE GENES FOR SICKLE CELLS AND THE A-B BLOOD GROUPS

| Finney Type | Family Number | a | b | c | d | $\gamma$ | K      |
|-------------|---------------|---|---|---|---|----------|--------|
| 5           | 1             | 1 | 1 | 1 | 2 | -2.000   | 10.000 |
| 5           | 15            | 1 | 1 | 0 | 0 | -1.000   | 1.000  |
| 5           | 20            | 2 | 1 | 1 | 2 | -1.000   | 15.000 |
| 5           | 30            | 1 | 1 | 0 | 0 | -1.000   | 1.000  |
| 5           | 34            | 2 | 0 | 2 | 0 | -2.000   | 6.000  |
| 5           | 35            | 1 | 1 | 2 | 1 | -2.000   | 10.000 |
| 6           | 16            | 1 | 1 | 0 | 0 | -0.333   | 0.238  |
| 7           | 36            | 0 | 0 | 2 | 2 | -0.222   | 1.333  |
| 7           | 37            | 1 | 0 | 1 | 1 | -0.111   | 0.778  |
| 7           | 38            | 2 | 0 | 3 | 1 | -0.500   | 2.778  |
| 7           | 39            | 1 | 0 | 2 | 1 | -8.444   | 1.333  |
|             |               |   |   |   |   | -18.610  | 49.460 |

TABLE III  
LINKAGE DATA ON THE GENES FOR SICKLE CELLS AND THE RH BLOOD TYPES

| Finney Type | Family Number | a | b | c | d | $\gamma$ | K      |
|-------------|---------------|---|---|---|---|----------|--------|
| 5           | 5             | 1 | 0 | 1 | 2 | 0.000    | 6.000  |
| 5           | 6             | 0 | 1 | 1 | 0 | 1.000    | 3.000  |
| 5           | 10            | 1 | 1 | 0 | 0 | -1.000   | 1.000  |
| 5           | 12            | 3 | 0 | 1 | 0 | 0.000    | 6.000  |
| 5           | 30            | 1 | 1 | 0 | 0 | -1.000   | 1.000  |
| 6           | 8             | 1 | 0 | 0 | 2 | 1.000    | 0.540  |
| 6           | 16            | 1 | 0 | 1 | 0 | -0.111   | 0.238  |
| 7           | 38            | 3 | 1 | 2 | 0 | -0.555   | 2.778  |
| 7           | 39            | 1 | 2 | 0 | 1 | -1.333   | 1.333  |
| 7           | 40            | 2 | 0 | 0 | 1 | 0.778    | 0.778  |
| 8           | 36            | 1 | 1 | 1 | 1 | -1.037   | 0.836  |
|             |               |   |   |   |   | -1.502   | 23.512 |

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## THE INFLUENCE OF GEOLOGY IN OHIO PLACE-NAMES

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Except for those of Indian origin, surprisingly few place-names in Ohio sprang from that most direct manner of choosing a name—the geography, geology, or environment of the locality. The Indian, having little tradition or historical ties in his background, selected his names from appearances, and usually with an association, sometimes general, sometimes pointed, to surroundings. The Indian word from which *Ohio* was derived is said to have meant “beautiful river”. Sandusky was named for its cold streams, the Tuscarawas for “wide mouth”. Hocking signified “the gourd” or “the bottle” because of the resemblance, in the rock basin and spillway at its edge, at Rock Mill. The Indian’s name for Mt. Pleasant at Lancaster was “The Standingstone”, a choice certainly far more vivid than the present designation.

It is almost impossible to trace Indian names to their derivation because of dialects involved, and because to white men who tried to record them, the originals were full of strange consonants and misleading gutturals. As a result, Indian names were handled roughly as they went through French and then English translations, and they were even more severely dealt with by early cartographers who received them orally from explorers and soldiers. Occasional names took a form that made their source uncertain—they may equally well have been Indian or French or English. Chagrin is such a word. According to the well-known account, it was given by Moses Cleaveland in 1796 when he and the exploring group he led mistook the Chagrin River for the Cuyahoga, and when, upon discovering their error, Cleaveland chose the particular name because it expressed the emotional reaction of his party. Bearing in mind that this is a region where other large streams have names of French origin—Grand, Roche (now Rocky) and Vermilion—and the fact that the word “chagrin” seems strangely out of character, there is reasonable ground for being dubious as to the story. On Rufus Putnam’s map of January, 1804, the river is shown as *Shaguin*, and in early histories the name has been given as *Shagrin*, supposedly meaning, in local Indian dialect, “clear”. Finally, to confuse the matter further, Saguin’s Post, or French Town, is said to have been located a few miles away on the Cuyahoga in what is now Brooklyn Township.

While English-speaking people had little patience with Indian place-names, the French were careful to preserve them even though many of the originals were translated and preserved in the French form. Perhaps it is for the same reason that French on a menu is more enticing than English, nevertheless the fact is that French geographic names have an imagery and originality that is rarely equalled in English. Who wouldn’t prefer Baton Rouge to Red Stick, or even to Red Cypress, for which, because of the abundant cypress trees, the place was evidently named? Or where is the childlike idiom of the Indian better preserved than in the name Trempealeau? That huge rock hill, an island in the Mississippi, the Indian called “The Mountain Soaking in the Water”; the French equivalent, “La montagne qui trempe a l’eau” is descriptive poetry too rarely found in geographic names.

The origin of a geographic name is frequently difficult to trace because of outright changes. Even more difficulty results from modifications and distortions which some names underwent. Throughout the United States, any number of towns, rivers and lakes bear names entirely different than their originals, changes sometimes made by natives who had a struggle with the original spelling, sometimes (for the same reason, apparently) by the Post Office Department or the Board on

Geographic Names, and frequently with little credit to whatever person or agency was responsible. For English-speaking people had as little patience with French names as with Indian! In southern Arkansas, in a region with a liberal scattering of names of French origin, is the oil town, Smackover. Originally it was a trail, arched over by spreading trees, and the French named it the "covered way", or *Chemin Couvert*. Now, *Chemin Couvert* was hard to say and harder to spell, so it became something sensible—first, Smack Cover, and then Smack Over. At the foot of the Gros Ventre mountains—a name, by the way, for the anatomical development of a particular tribe of Indians—is the town in Wyoming with the telescoped name *Grosvont*. In northern Michigan, the island Bois Blanc, named for the white birches, is known as Bob Lo; and in Missouri, Bois Brulé, meaning "burned woods", is *Bob Ruley*. Simplification is not alone to blame for ridiculous changes, for some resulted from such things as attempts at euphemism and polite speech. A few miles west of the Muskingum County line, on Route 40, is Buzzard Glory Knob, re-styled some years ago Crow's Nest—a change involving a contradiction of natural fact, and a substitution of the commonplace for a name that was bright with color and melody and motion.

Those who named early settlements believed as zealously as the father of Tristram Shandy in the destiny of a name, consequently many that were chosen were deliberately stilted. It has been said that Ohio is surpassed only by Pennsylvania (1) in the number of classical geographic names. Xenia, Gallipolis, and Akron (the last, it might be said, of geological origin) are a few of Ohio's classical names. Local color in the choice of a name was probably regarded as a handicap to future development. For many reasons, therefore, geological names are in the minority in Ohio. Where they can be found, they represent obscure and sometimes forgotten places, and often they have a narrow and frequently trivial application.

#### NAMES BASED ON WATER SUPPLY

One category into which geologic place-names are grouped is based on the source and nature of the water supply. The largest Ohio city so named, though from the frequency elsewhere it might be assumed to have been a "transferred" name, is Springfield. The first settler in Springfield was James Demint, who arrived in 1799. The site was surveyed in 1801 by John Daugherty, and the following year Simon Kenton moved to what is now West Springfield. The name Springfield was chosen by Mrs. Kenton because of the many springs along the cliffs of Buck Creek. Springboro, in northern Warren County, the site of a spring which is said by Fuller (2) to be one of the largest in southwestern Ohio, issues from thick drift deposits. Yellow Springs, in Greene County—particularly the largest spring which gave the place its name—flows from the Springfield limestone, and is so charged with calcium carbonate that it has built large deposits of travertine at the surface. The iron carbonate "chalybeate" water has given the deposits a definite rust-yellow color. At Green Springs, on the Seneca-Sandusky County line, a number of springs (3) come from the Tymochtee limestone. One of these discharges 8 million gallons per day, and was so prized by the Seneca Indians that, when the white man was about to take over the spring in 1814, the Indians attempted to choke off its flow by filling the basin with rocks and logs.

Two villages were given more descriptive names. Sinking Spring, in Adams County, was named for a small flow which, after emerging from Niagaran limestone, disappears underground in joints of eastward-dipping rocks. In Ross County is Spout Spring, now known as Humboldt, an artesian-like discharge from the contact of the Ohio shale and the underlying limestone, which at one time spouted water from a hollow log driven horizontally into the crevice.

The town adjacent to the largest spring in northern Ohio was given a classical name—Castalia. Water from nearby Blue Hole in a volume of approximately 7 million gallons per day is responsible for the name of Cold Creek, and also the

Indian "Sandusky", which had the same meaning. Another city with a classical, and probably the most musical name in Ohio, is Bellefontaine, so called because of the numerous springs from the limestone outlier and glacial gravels around it.

#### NAMES FROM MINERAL RESOURCES

Mineral resources have been the basis for most of Ohio's geological place-names, and, as might be expected, coal leads all others. The first coal used in Cleveland (4) and on Lake Erie was shipped over the then new Ohio canal in 1828, and came from Coal Hill in Tallmadge Township, Summit County, from a mine owned by Henry Newberry, the father of J. S. Newberry the geologist. Coalburg, in the southeast corner of Trumbull County, furnished one of the first iron-making coals to be used anywhere. This was the Sharon coal, and because it could be used without first coking, it gave the Youngstown area an early impetus in the iron industry. In Weathersfield Township, Trumbull County, the Sharon coal and associated Black Band ore gave the name to Mineral Ridge. The iron ore known as "American Scotch" was mined under the ridge and was once important in the industry throughout the entire Mahoning valley. In Athens County, two mining towns were named from the Middle Kittanning coal—Carbondale and Mineral, both in Waterloo Township. Coalton, in Jackson County, was the site of coal operations as early as 1878 in the Quakertown coal. Cannelville, in Brush Creek Township, Muskingum County, was named for the cannel<sup>1</sup> characteristics of the upper part of the Upper Freeport coal, though the Middle Kittanning was later the important bed there. In Waterford Township, Washington County, the Meigs Creek coal is mined in the vicinity of Coal Run. At Minerton, in Vinton County, the Clarion Coal and Vanport limestone were once important. In the same county, the Ferriferous ore was formerly mined by stripping at Oreton, and was used extensively in the iron industry then flourishing in southern Ohio.

At Ironton, the Ferriferous limestone was used as a flux for the iron ore lying immediately above it, and together they made the name Ironton famous for its furnaces. There have been two Galenas in Ohio—the present one in Delaware County was first known as Zoar when founded in the spring of 1816. The other, in northwestern Scioto County, is now called Rarden. Lead being practically unknown in rocks in Ohio, there is no good basis for the mineral origin of the names. The Sunbury shale in the first instance, and the Ohio shale in the second contain many scattered nuggets of pyrite though "Fools Gold" would never do for a town.

The flinty phase of the Vanport limestone is responsible for the name Flint Ridge, in Licking and Muskingum Counties. At Glass Rock, Perry County, the Sharon conglomerate has been quarried and the product shipped for many years for the manufacture of glass. In Lucas County, the Sylvania sandstone (5) has been quarried since 1863 at Silica, from which point the sand has been shipped to such centers as Pittsburgh for glassmaking. In the vicinity of Sandusky Bay, rock gypsum was discovered (6) in the upper part of the Monroe series in 1821, and the town of Gypsum is today a center for quarrying the mineral. Green Island in Lake Erie, southwest of Put-In-Bay, was formerly called Strontian Island for the crystals of celestite (strontium sulphate) so well developed in cavities in the dolomite. In Lake County, the plant of the Diamond Alkali Company, where chemical brine is produced from the Salina series, is located at Alkali.

Salineville, in southwestern Columbiana County, was the site of salt springs and later salt wells, the first of the wells being drilled in 1809, with about twenty producing by 1835, and the last one abandoned in 1880. There are at least three Salt Creeks in Ohio, all once having salt springs along their banks. The one in

<sup>1</sup>A coal formed largely from plant spores and pollen. The name seems to have been a corruption of *candle*, given to the coal because of the ease with which it ignites and the yellow, luminous flame when burning.

Holmes County, flowing into Killbuck Creek, attracted settlers as early as 1809. Putnam's map of 1804 shows salt springs on both the Salt Creek which flows into the Muskingum below Duncan's Falls and the one entering the Scioto in the southeast corner of Ross County.

At White Sulphur, 5 miles southwest of Delaware, the saline sulphur springs were at one time better known than they are now. When the water of the springs was evaporated, a white residue of sodium chloride and other salts remained, once supposed to be sulphur. From the Ohio shale along the banks, the efflorescence of the mineral melanterite or copperas, improperly called alum because of its white color and astringent taste, gave the name to (7) Alum Creek. Along the narrows of Paint Creek in Ross County, the same mineral on the walls of Ohio shale was responsible for the gorge being called Alum Cliffs. A short distance west, the fantastic bluff of under-cut shale is known as Copperas Mountain. In each case, the melanterite was produced through the action of ground water and oxidation of iron sulphide in the shale.

On the Ohio River, 5 miles below Marietta, is Gravel Bank. This outwash deposit lies about 100 feet above present stream level, and in the early days of railroad building (8) furnished more ballast and railroad gravel than any other source in southern Ohio. About ten miles above Marietta, Rainbow Creek enters the Muskingum from the west. Seepages of oil from shallow outcrops and leakage from early wells left iridescent filmy patches on the stream. Hence, from the varicolored hues on the water, the terms Rainbow Creek and the name of the village Rainbow.

#### STRATIGRAPHIC NAMES

Some geographic names originated in connection with local stratigraphy. The Columbus limestone, because of its crystalline nature and the fact that it polished well, was once thought to resemble marble, and so we have Marble Cliff on the west bank of the Scioto at Columbus. Along the Muskingum River south of Zanesville, prominent cliffs are formed by a coarse sandstone, the Cow Run. In many places the rock is covered with lichens, and where it is moist the surface is a definite blue-green. The town on the river at the foot of the rock bluffs is Blue Rock. In southwestern Ohio, on the Greene-Clark county line, the Little Miami river drops over the Niagara escarpment, formed by the outcrop of the Springfield and Cedarville limestones, at the village of Clifton. In Lawrence County, sandstone cliffs in which the Clarion sandstone is prominent overhang "like the cornice of a house" at Hanging Rock.

Rockville was located on the Ohio River at the east line of Adams County. As early as 1814, the Buena Vista sandstone of the Cuyahoga was quarried here, and in 1831 the rock for the Ohio River locks at Cincinnati was taken from these quarries. Starting about 1840, a lower ledge was much used in buildings in Cincinnati and was known as the "City Ledge". The rock was also used in buildings in Pittsburgh, Detroit, Chicago, and other cities. Another Rockville located north of Greenfield in Fayette County, on the outcrop of the Monroe, is now known as Rock Mills. Berea sandstone was quarried in the nineties at Stoneville, in the southwest corner of Ashtabula County. Rockbridge in Hocking County is named for the near-by natural bridge in the Black Hand sandstone. An important source of building stone was at Freestone in Scioto County, where sandstone layers of the Cuyahoga were worked and shipped to points as far away as Baltimore, Chicago, Alberta and New Orleans.

Mt. Gilead was originally settled as Whetstone, where Whetstone Creek crosses the outcrop of one of the country's finest natural abrasives, the Berea Grit. In the northeast corner of Seneca County is the town Flat Rock, where the Delaware limestone, lying in thin layers with little soil cover, is on the surface. Flat Rock

Creek is in Paulding County, and was probably named for the thin, plate-like slabs of Tymochtee limestone in its bed.

There are any number of Slate Runs in Ohio, the largest in Huron County, tributary to the west branch of the Huron River. From Siam to Monroeville, Slate Run crosses the Ohio shale. Slate Mills in Ross County is on the north fork of Paint Creek at the outcrop of the Ohio shale.

A short distance beyond the southeast corner of Franklin County is Lithopolis, where the Berea and Cuyahoga outcrop and where the latter sandstone was once quarried for window sills and caps. From the Greek for "stone" and "city," Lithopolis is by coincidence a fitting name for the place of birth of a dictionary publisher.

#### ALTITUDE AND NAMES

There are localities, too, named for their elevation. At the time of the organization of Highland County in 1805, the county seat, Hillsboro, was thought to be the highest point in Ohio. Because of the elevation of the country about it, the county was called Highland. The name of Belmont County was for the beauty of the montaine topography. Altitude, a few miles east of Woodsfield in Monroe County, is perched at an elevation of 1210 feet, about 400 feet above Sunfish Creek, which flows in the adjacent trenched gorge. The divide between Lake Erie and the Ohio River extends diagonally across the southern part of Summit County, and this being the highest area traversed by the Ohio Canal, the county was named Summit when founded in 1840. Akron, for the Greek "high", was the name given the county seat. Many names of this kind are those of railroad towns. On the D. T. and I., in southeast Ross County, is Summithill, at the crest of one of the steepest railroad grades in Ohio. In a series of spectacular bends and turns the railroad climbs from an elevation of 723 feet at Bainbridge to 1085 at Summithill, and descends to 572 feet at Waverly. Crestline, in Crawford County, was originally known as Livingston when the Cleveland, Cincinnati, Chicago and Indianapolis railroad was built in 1850. When, in 1852, the Pennsylvania railroad reached the village, a new town was begun. This was called Crestline, and when the towns merged, the name Livingston disappeared. Crestline lies between the northeast extension of the Broadway and Powell moraines at about 1170 feet elevation, and it is said that it, too, was at one time thought to be one of the high points in the State.

On the northern boundary of Wayne County, and on the Allegheny escarpment, is Creston—likewise a railroad town, the elevation of which is about 1000 feet. On the Logan-Hardin county line, and on the St. John's-Mt. Victory moraine, is Ridgeway. Two divisions of the New York Central cross here at an elevation of about 1060 feet.

Although there are many "mountains" in Ohio having specific names, one of them should be mentioned because of its geographic prominence. Little Mountain is on the Lake-Geauga county line, about 7 miles northwest of Chardon. This knob, capped by Sharon conglomerate, lies on the Portage escarpment. From its summit of nearly 1300 feet elevation, overlooking to the north the beaches of Lakes Maumee, Whittlesey and Warren, and with Lake Erie in the distance, the view (9) from Little Mountain is one of the most impressive in Ohio.

#### PHYSIOGRAPHIC NAMES

Some localities were named for their physiographic setting. Plain City, in Madison County, is located on the "Darby Plains", a portion of the flat Wisconsin ground morain. Prairie Depot, Wood County, is on the monotonous "black swamp" of Lake Warren. Belpre, in Washington County on the flood plain of the Ohio River, has a name of French origin meaning "fine meadowland". South

Point, on the Ohio in Lawrence County, is very near the southernmost point in Ohio, and bears a name which is geographic rather than geologic. Moraine City, now a part of Dayton, lies on the dissected Bloomington moraine of the Wisconsin drift sheet.

In Ottawa County, a resistant ridge of Guelph dolomite is called Rocky Ridge, and in Henry County, a village on the beach ridge of Lake Whittlesey is known as Ridgeville Corners. On an old shore line south of Conneaut in Ashtabula County is South Ridge, and in Lorain County, North Ridgeville is located on the beach ridge of Lake Warren, the northernmost of three old shore lines.

In Fairfield County, the topographic map shows Slough, a small community a short distance east of Lithopolis. A few hundred yards west of Slough is a marshy area (10) of glacial lacustrine deposit, the result of a northward-flowing stream being blocked by Wisconsin ice and the recessional moraine the ice left.

In Boston Township, Summit County, is the village of Peninsula. The town antedates the railroad, which was not built until 1873, but the Ohio Canal, following the Cuyahoga at this point, had been completed in the early 1820's. From the river and the canal, the steep bluff, capped by Sharon conglomerate, juts into the stream in a narrow promontory so that even though far inland, to a "canawler", this was indeed a "peninsula".

#### NAMES INDIRECTLY RELATED TO GEOLOGY

There are certain geographic names derived from the manner in which the local rocks affected the scenery or impressed the observer. Yellow Creek, in Jefferson County, was so called because of its iron-charged water coming from drainage at the level of coal beds. Iron-depositing bacteria and algae coated every rock and pebble and assisted to give the stream channel its bright color. Another Yellow Creek enters the Mahoning River at Poland. The Black River in Lorain County was probably named from the gloom of its deep valley, resulting from both the black Ohio shale and the heavy foliage along the steep valley walls. Rocky River cuts through rocks extending from the Chagrin to the Cuyahoga, and because of its steep gradient, the stream has swept away smaller fragments but has left its channel strewn with the large pieces of rock debris. The Vermilion River was named for the brick-red color resulting where the Ohio shale had been exposed to fire. The burned shale was used by the Indians for red pigment. The name Paint Creek, west of Chillicothe, was in all likelihood given for the same reason.

Because of the fact that early names were not recorded, it is possible that many may have had a geological origin. In times when the transmission of a word was oral and not written, when few of the early transients or residents were expert spellers, and when, particularly, French words and Indian dialects were involved, it is surprising that original forms have been preserved at all. Undoubtedly, many place-names have been altered in adapting them to English. When Anthony Wayne was in northwestern Ohio, a journal (11) was kept for him by one Lieutenant Boyer through which, repeatedly, the river Auglaize is written *Oglaize*. The word Auglaize is said by many authorities to have been Indian and to have meant "fallen timber". The word looks and sounds French, however, and it might be noted that forms such as Au, Aux, Eau and other variants, all applied to streams, are found throughout the world in regions traversed or settled by the French. Lieutenant Boyer's phonetic "O" suggests, especially with the spelling "Au", a French origin. The Auglaize is a larger stream than is sometimes supposed—it is exceeded in drainage area, in fact, by but five Ohio rivers—yet is has one of the lowest gradients in the State. With its low gradient and its leisurely flow, the mirrored surface of its waters may have been the reason for the second syllable of the name.

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